31st Annual ECHO Hawaii

January 19, 2022 | 10:15 – 10:30 AM | 15 min

Mitral Clip: Who Is It for? How Is It Guided?

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Disclosures

Speakers Bureau (Abbott, Boston Scientific, Medtronic, Philips)
Advisory Board (Siemens)

Mitral Interventions

A	B	C	D
MitraClip	Transcatheter Mitral Valve Replacement (TMVR)	Prosthetic Paravalvular Leak (PVL) Closure	Valve-in-Valve
Pascal: MitraClip Alternative			Valve-in-Ring
			Valve-in-MAC

Mitral Interventions

A

MitraClip (Abbott)
FDA Approved for
Degenerative & Functional MR

Pascal (Edwards)
Clinical Trials
In Progress

Mitral Transcatheter
Edge-to-Edge
Repair (TEER)

Approval in the United States

MitraClip is approved for both
degenerative AND functional mitral regurgitation repair

Degenerative MR	**Functional MR**
MitraClip approved by FDA in **2013**	MitraClip approved by FDA in **2019**

Degenerative vs. Functional Mitral Regurgitation

Degenerative vs. Functional Mitral Regurgitation

Geriatrics & Aging 2003;6:42-45.

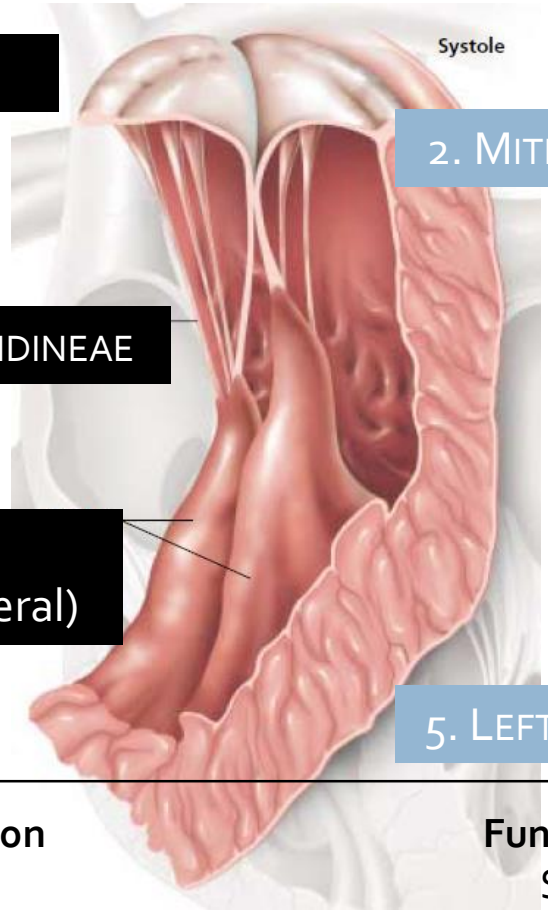
1. LEAFLETS

2. MITRAL ANNULUS

3. CHORDAE TENDINEAE

4. PAPILLARY MUSCLES
(posteromedial + anterolateral)

5. LEFT VENTRICULAR MYOCARDIUM



Degenerative Mitral Regurgitation
Sick valve >>> sick ventricle

Functional Mitral Regurgitation
Sick ventricle >> sick valve

Degenerative Mitral Regurgitation

REVIEW

Mitral valve prolapse: role of 3D echocardiography in diagnosis

Ricardo Benenstein and Muhamed Saric

Purpose of review
To review the utility and the latest developments in three-dimensional (3D) echocardiography of mitral valve prolapse.

Recent findings
Although 3D echocardiography was invented in 1974, it did not gain wide clinical acceptance until the introduction of real-time 3D echocardiography in the first decade of the 21st century. Driven by improvements in probe technology and increases in computing power, 3D echocardiography now provides unprecedented images of mitral valve prolapse and its associated mitral regurgitation with no or minimal requirements for image post processing.

Summary
3D echocardiography has become the echocardiographic modality of choice for establishing the diagnosis, describing the precise anatomy, and visualization of mitral regurgitant jets in mitral valve prolapse. 3D echocardiography is becoming indispensable in guiding surgical and percutaneous methods of mitral valve repair and replacement.

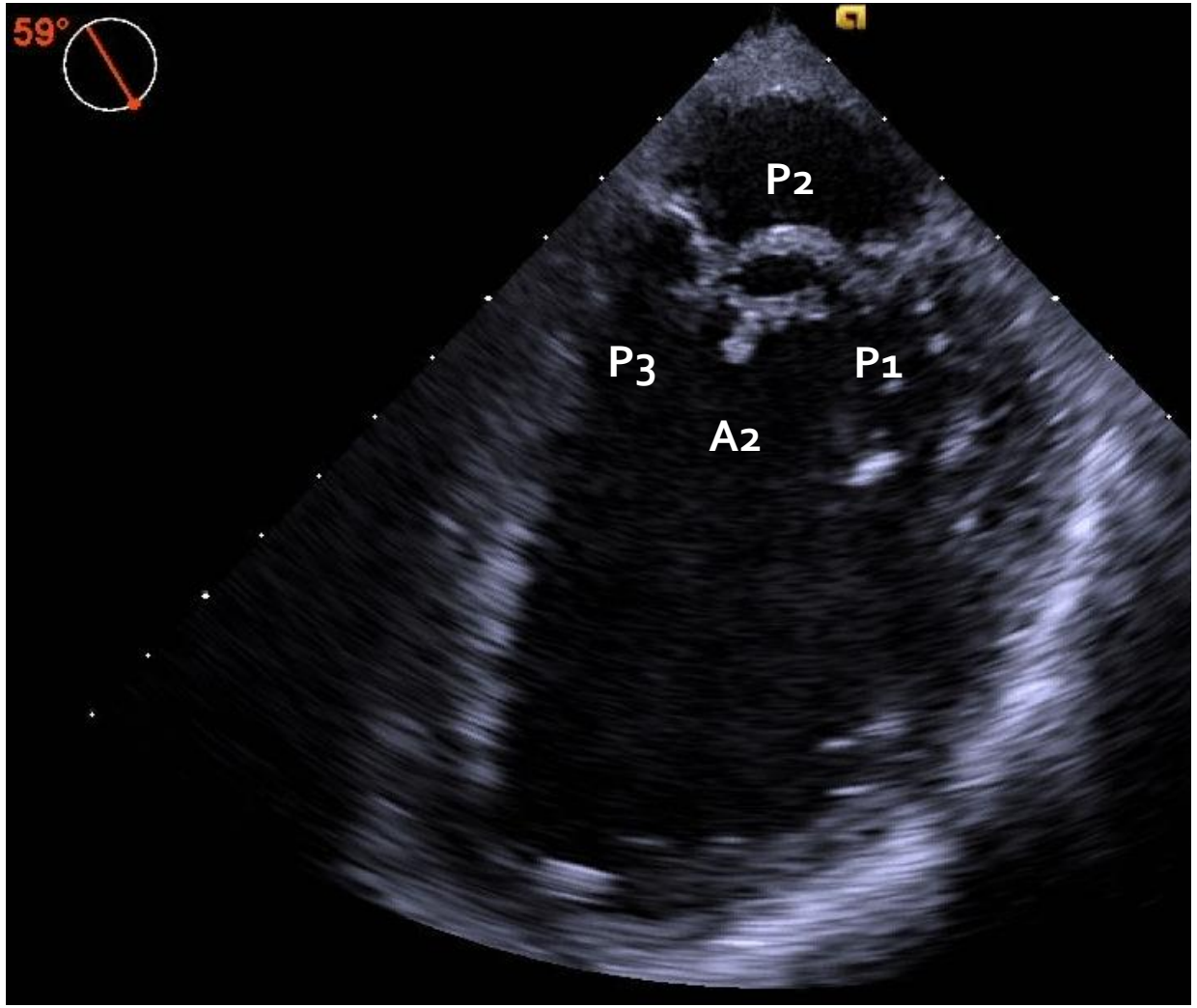
Keywords
mitral valve prolapse, real-time 3D echocardiography, transesophageal echocardiography, transthoracic echocardiography

INTRODUCTION

The word prolapse (from Latin 'to slip forward') has been used since the 17th century to refer to slipping of a body part (such as the uterus) from its usual position. It appears that the term prolapse was first applied to the mitral valve in 1966 by Criley *et al.* [1]. annulus, MVP is often difficult to fully characterize by cross-sectional imaging techniques such as 2D echocardiography. Real-time three-dimensional (3D) echocardiography – notably 3D transesophageal echocardiography (3D-TEE) – provides unprecedented views of the mitral valve apparatus, including the unique real-time *en face* view of the

Degenerative MR – Prolapsed / Flail Segment

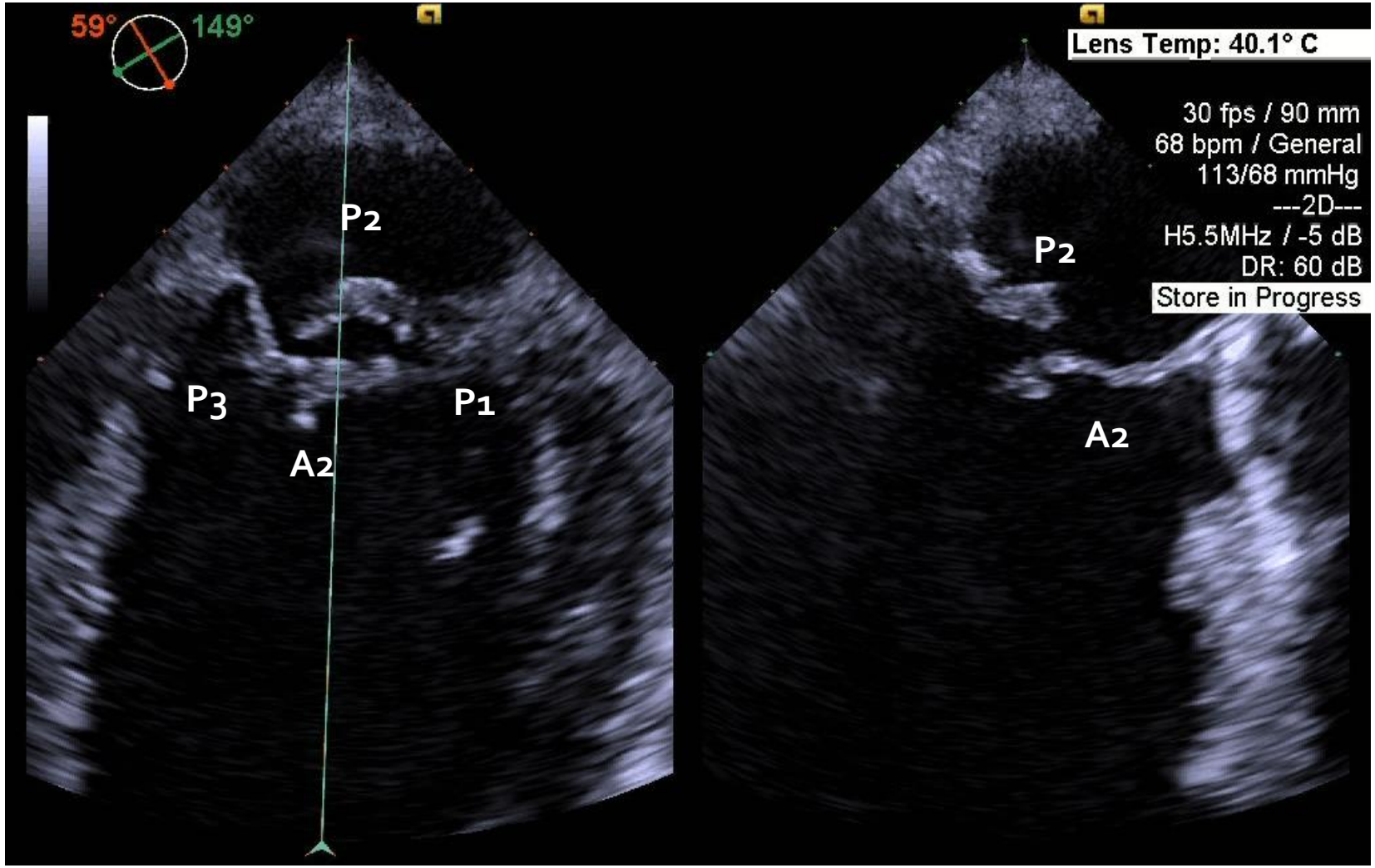
82-year-old woman
Sudden onset
of exertional dyspnea



COBRA SIGN
P2 OVER A2

Degenerative MR – Prolapsed / Flail Segment

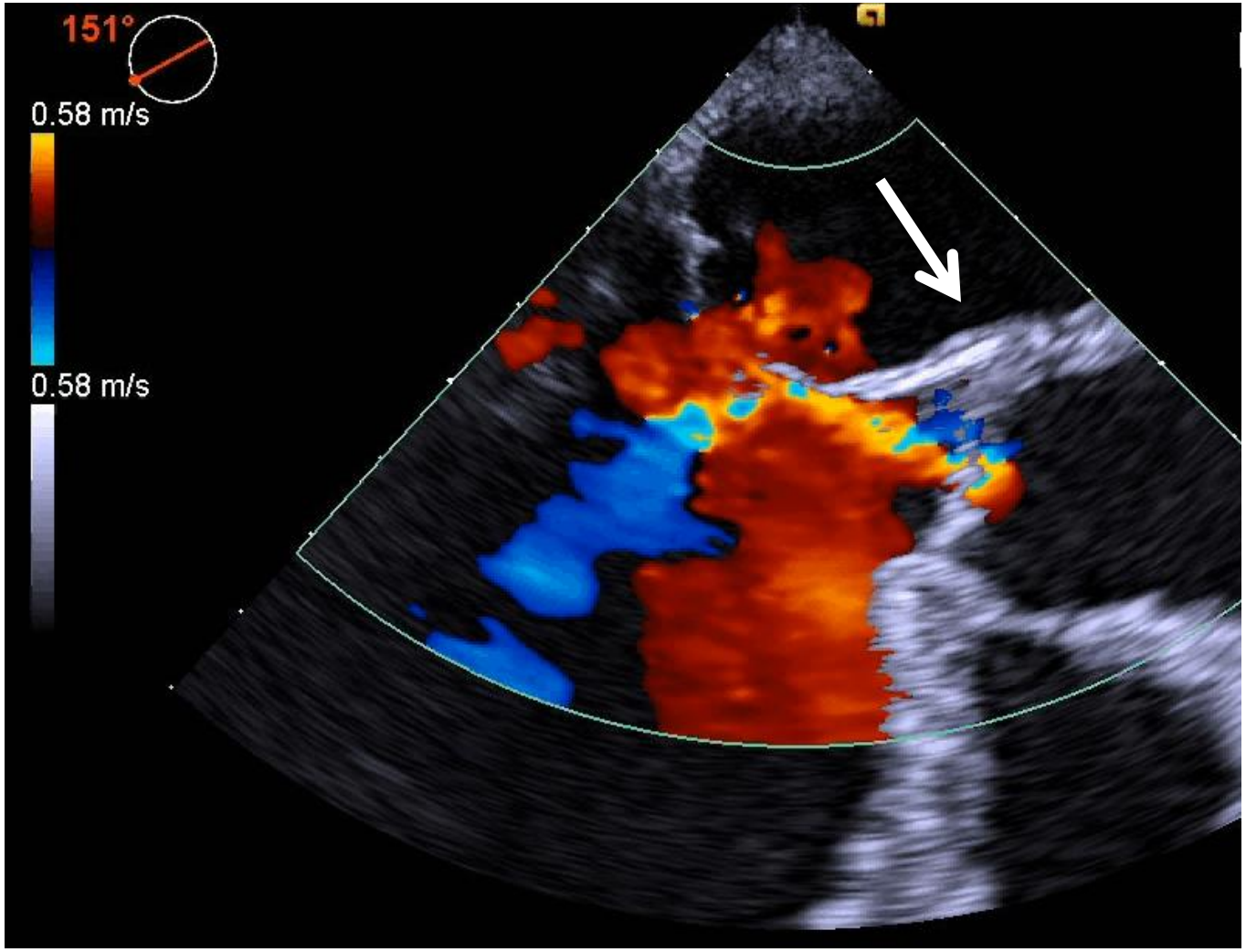
82-year-old woman
Sudden onset
of exertional dyspnea



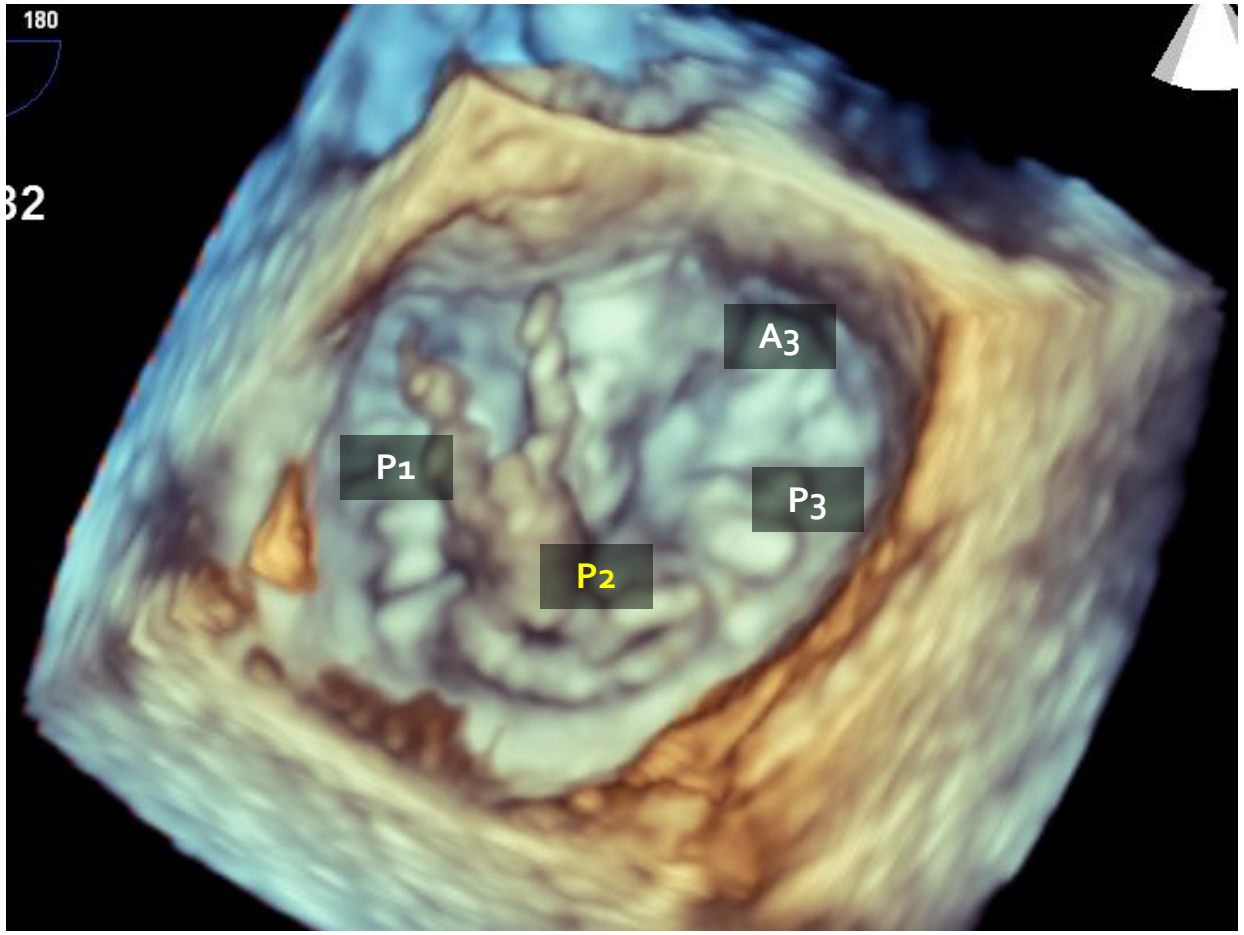
Degenerative MR – Prolapsed / Flail Segment

82-year-old woman
Sudden onset
of exertional dyspnea

Henri Coandă
(1886-1972)
Romanian
Aeronautics Engineer

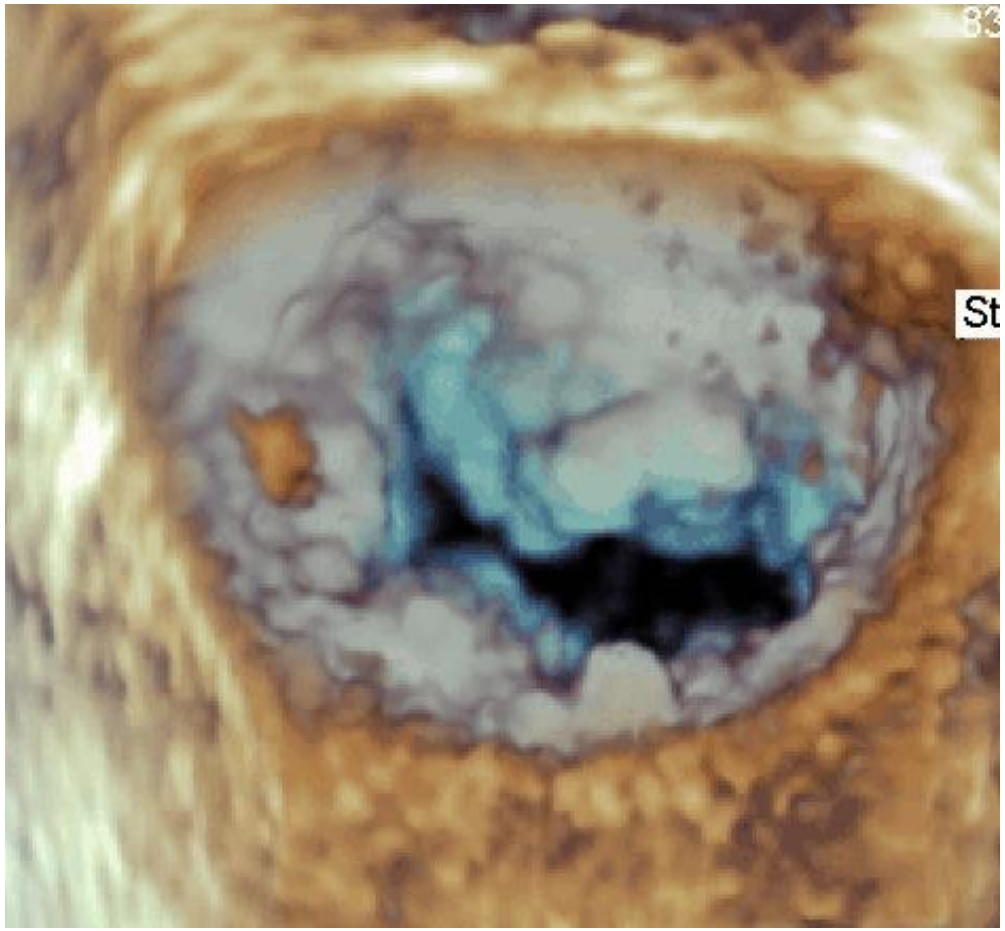


3D TEE: Flail P2



'SNAIL SIGN'

3D TEE: Flail P2



'SNAIL SIGN'

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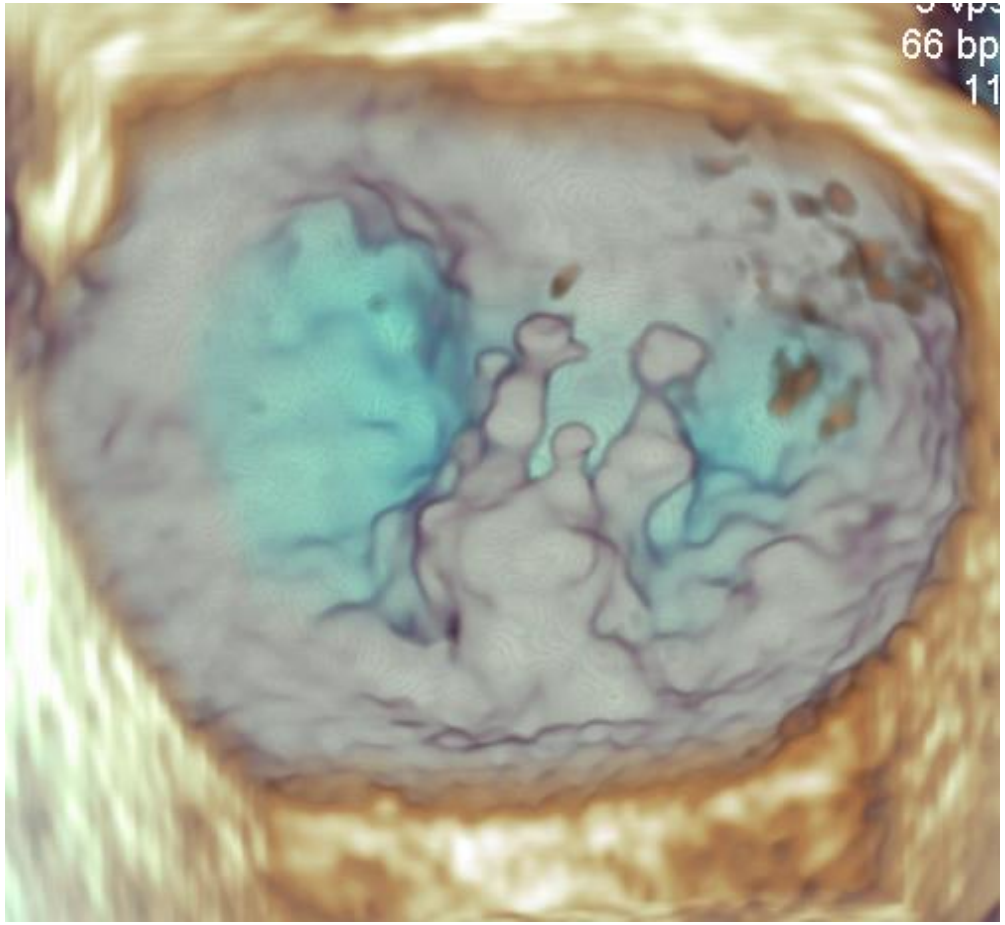


'SNAIL SIGN'

Functional Mitral Regurgitation

Carpentier Classification of Native Mitral Regurgitation

Alain Frédéric Carpentier
(b. 1933 in Toulouse)
French surgeon

Based on mitral leaflet mobility

Type I Normal Leaflet Mobility	**Type II** **Increased Leaflet Mobility**	**Type III** Decreased Leaflet Mobility
• Annular dilatation • Leaflet perforation	• Mitral valve prolapse • Ruptured chordae • Ruptured papillary muscle	• **IIIA** - Rheumatic • **IIIB** – Papillary muscle displacement (as in ischemic heart disease)

DEGENERATIVE MR

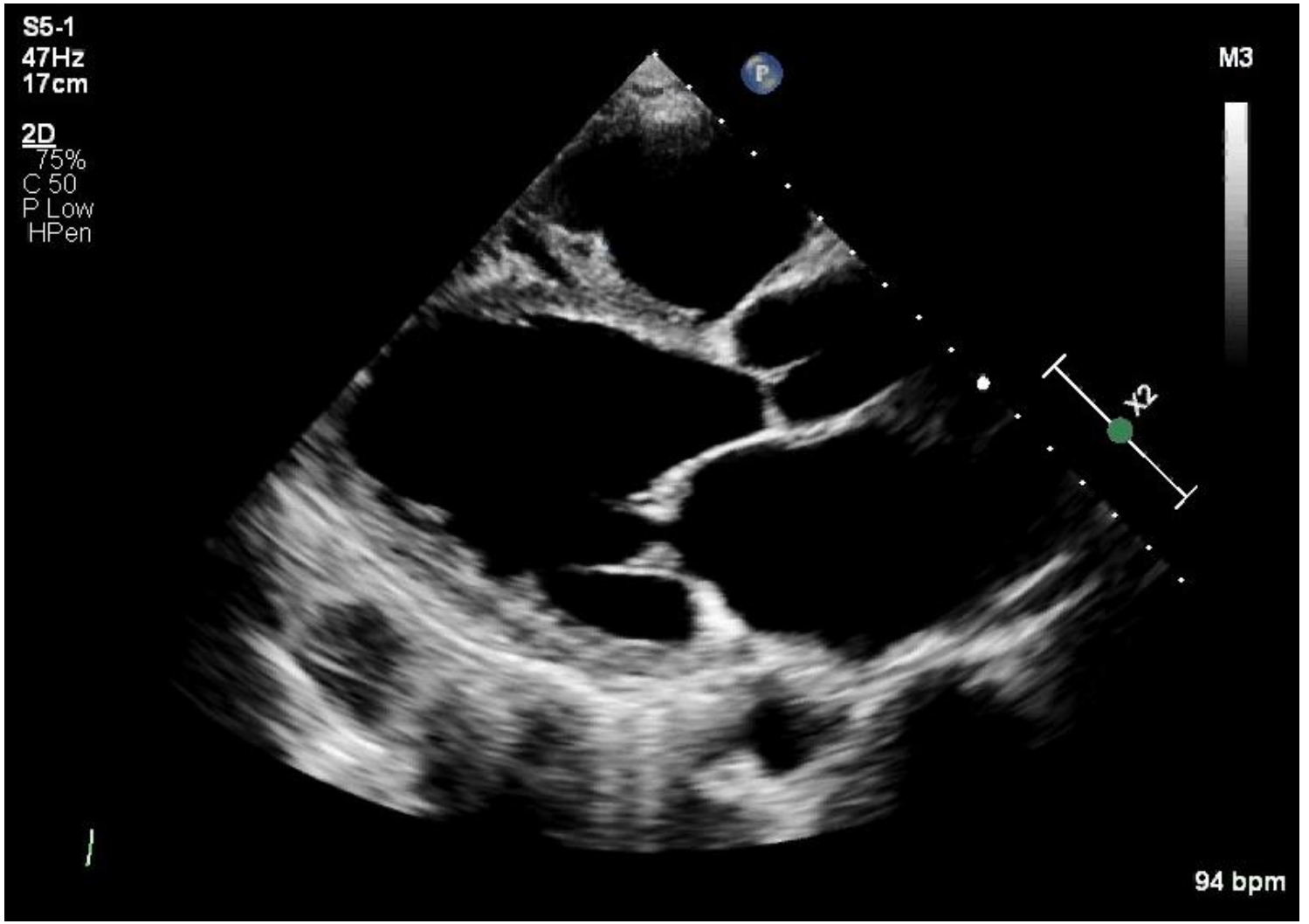
FUNCTIONAL MR

Carpentier A. Cardiac valve surgery—the "French correction." *J Thorac Cardiovasc Surg* **1983**;86:323–37.

The French Correction is a word play on The French Connection, a 1971 movie about smuggling heroin from Marseille to New York

Functional MR – Annular Dilatation

50-y/o man with
nonischemic
dilated cardiomyopathy
due to ethanol abuse



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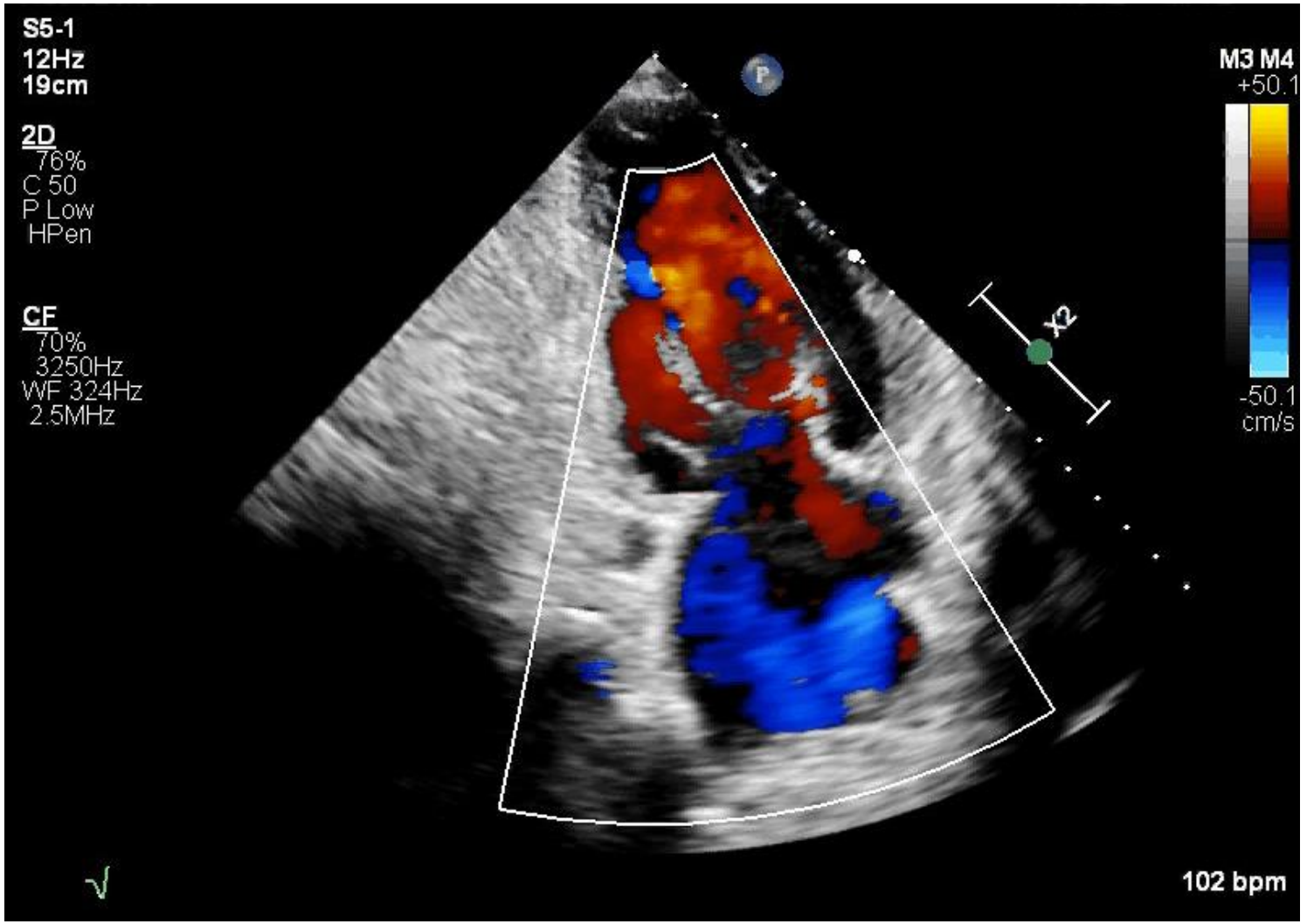
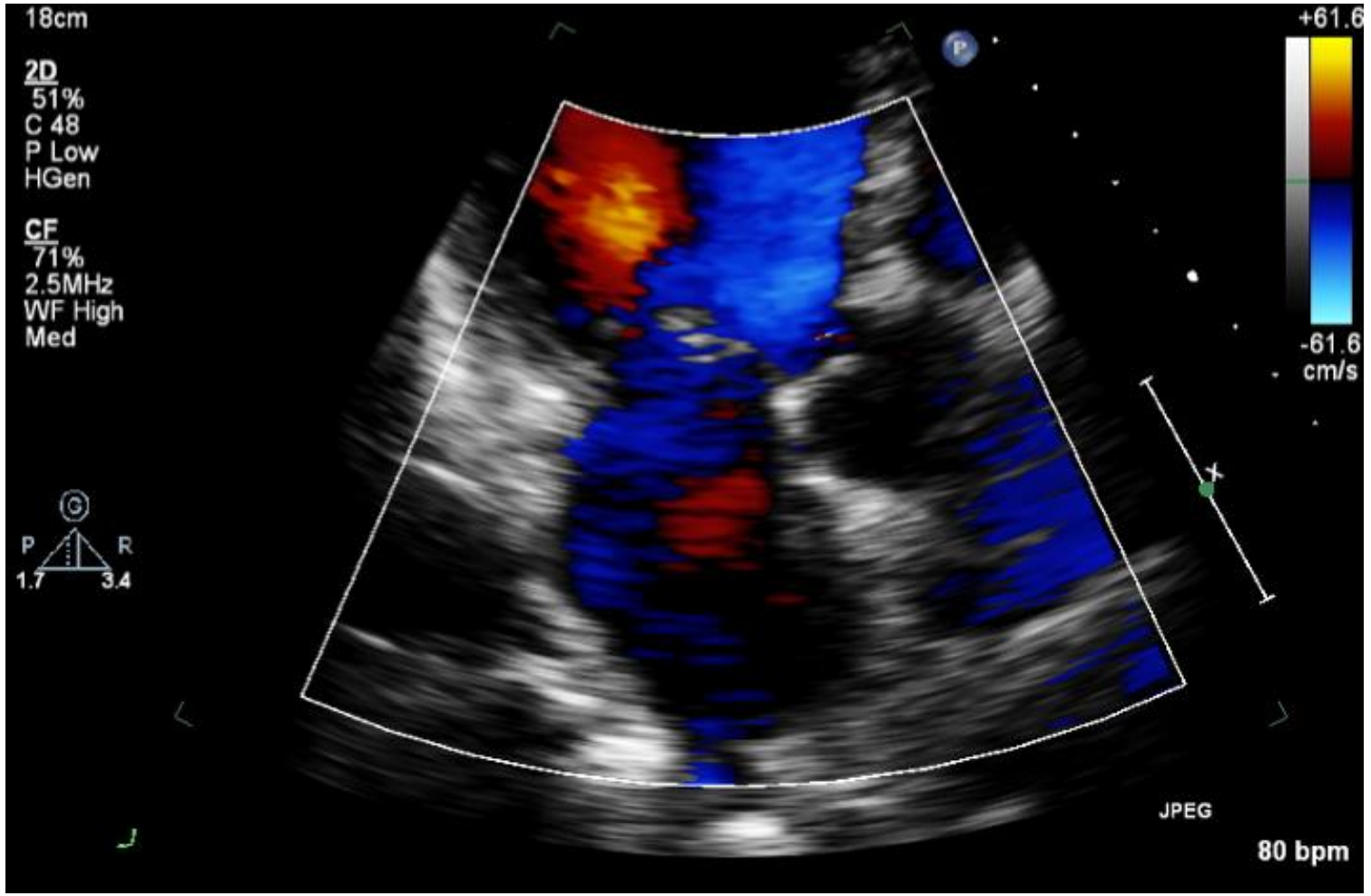


Functional MR – Ischemic Etiology

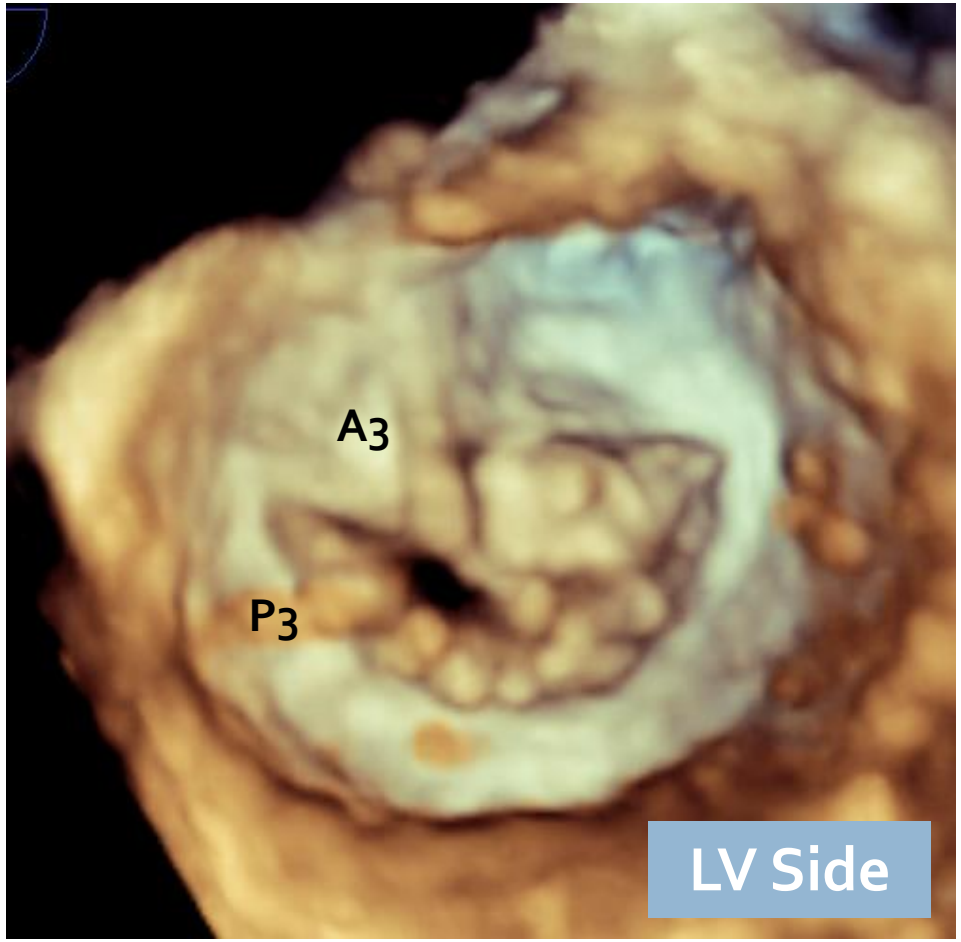
66-y/o man with **ischemic cardiomyopathy** (prior RCA infarct)

Functional MR – Ischemic Etiology

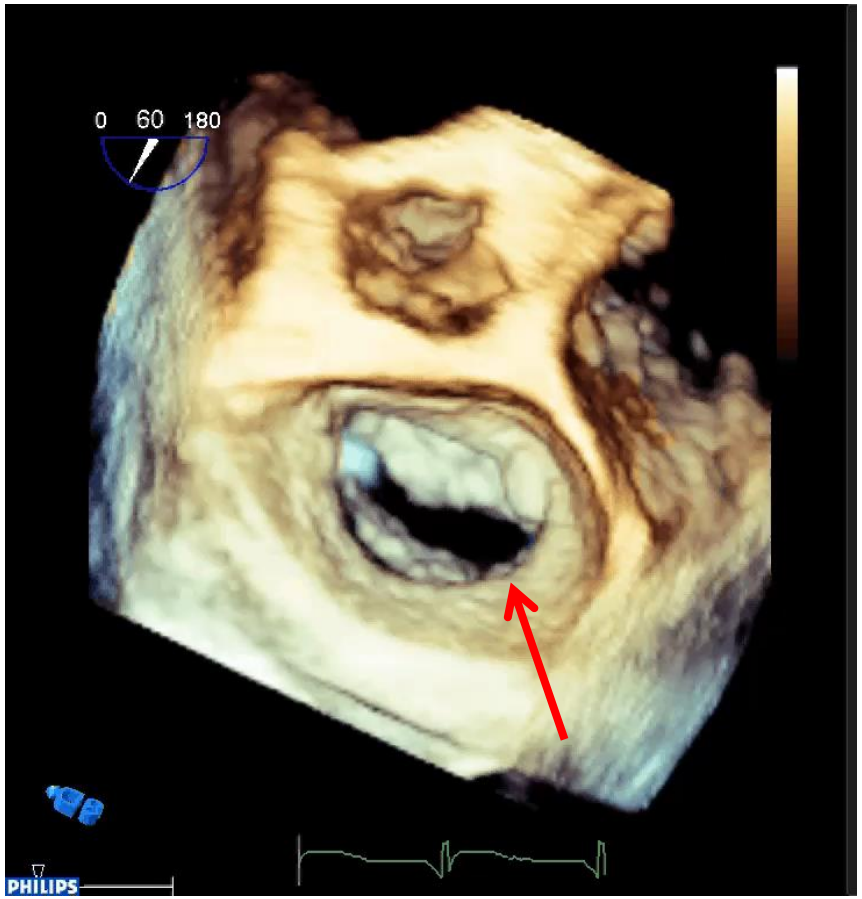
66-y/o man with **ischemic cardiomyopathy** (prior RCA infarct)

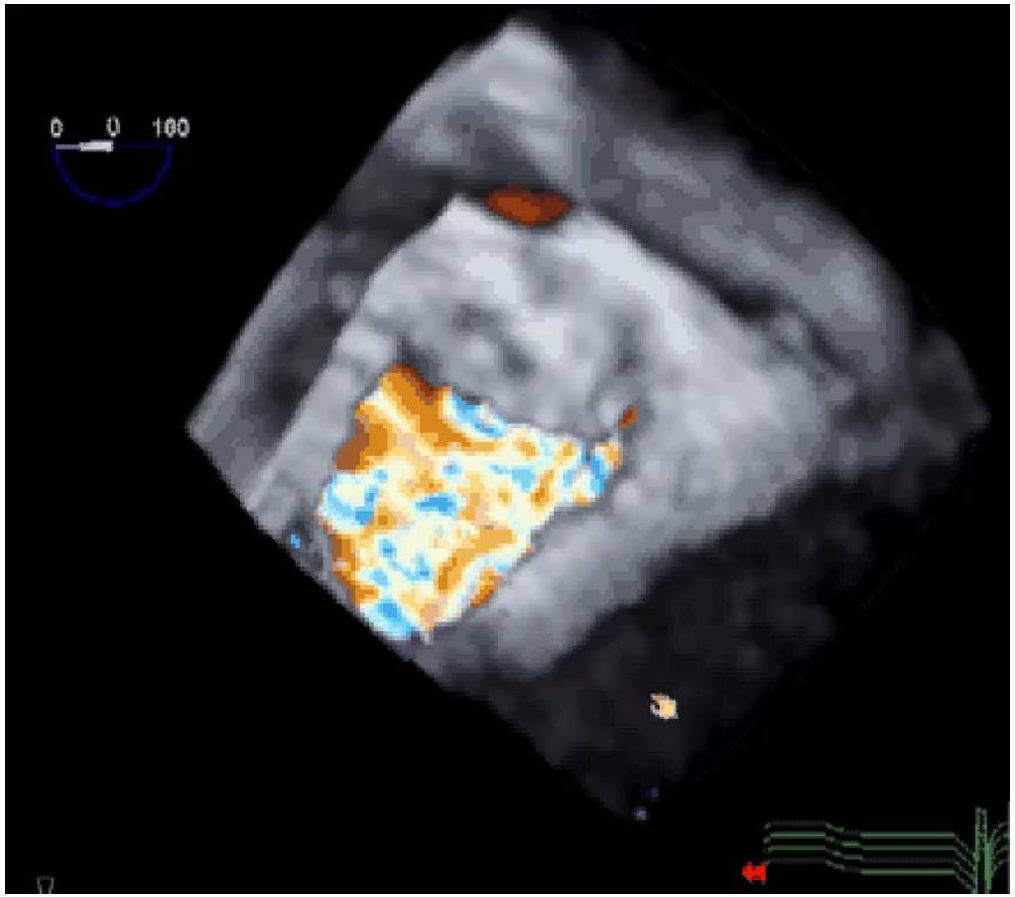


Functional Ischemic MR: Crooked Smile



Functional Ischemic MR: Crooked Smile



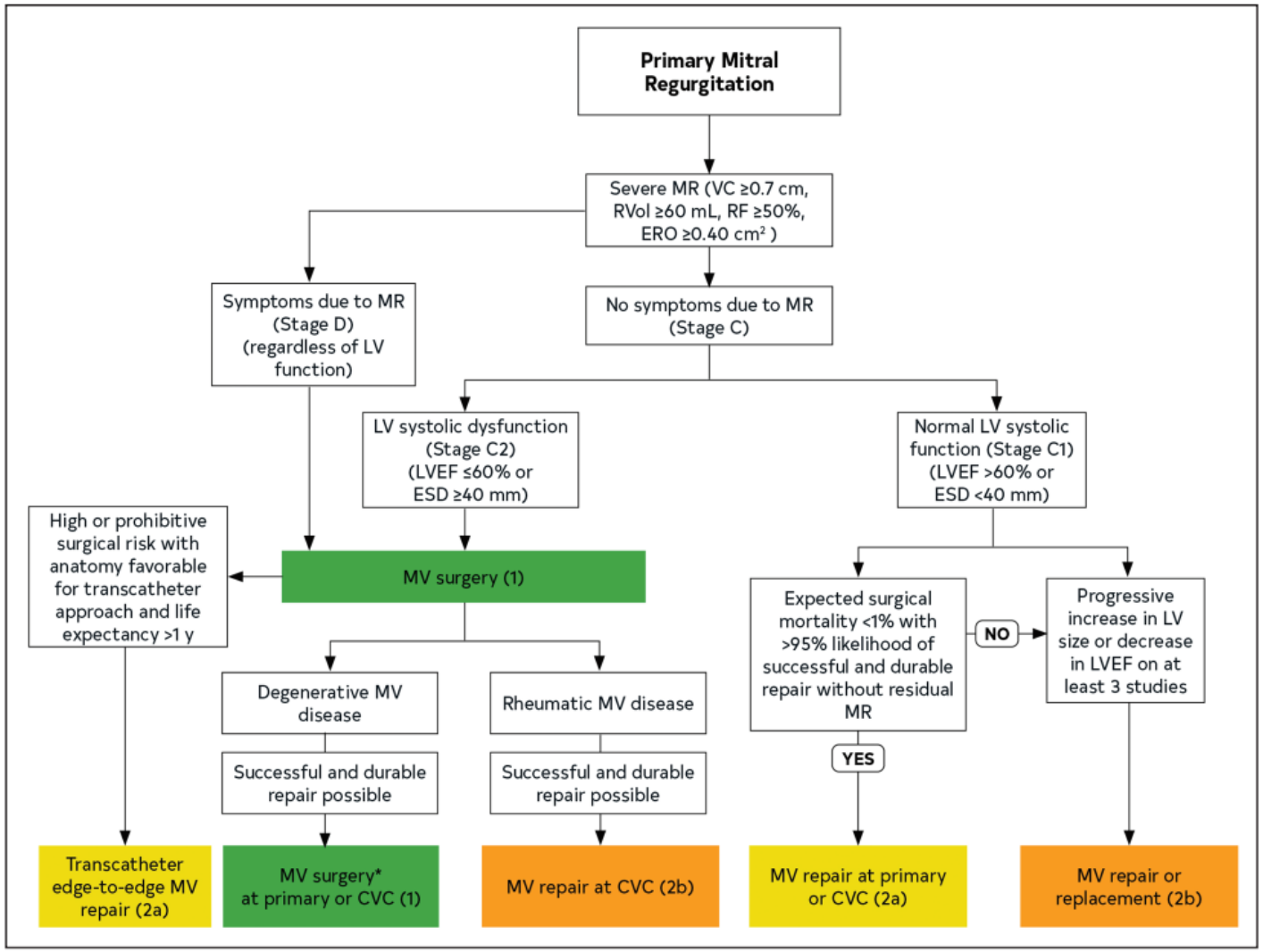


2020 ACC-AHA Indications for TEER

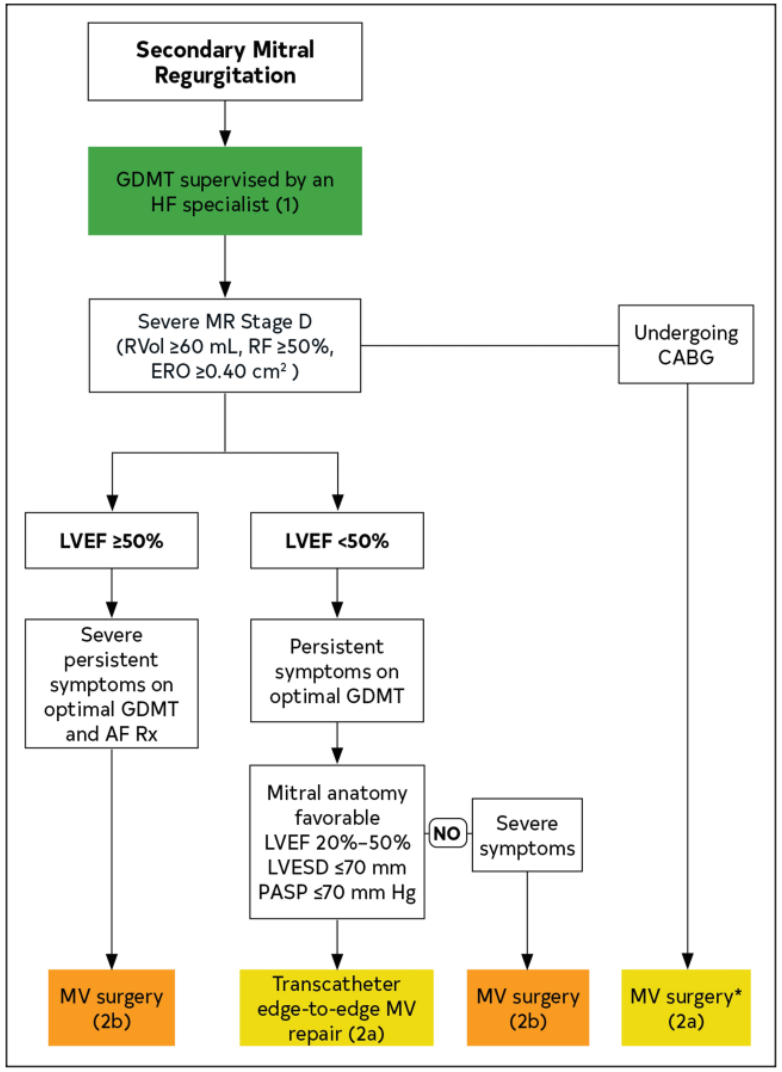
2020 ACC/AHA: TEER Recommendation

	1° Degenerative Mitral Regurgitation	**2° Functional Mitral Regurgitation**
MR Severity	Severe	Severe
Symptoms	Symptomatic	Persistent symptoms while on optimal GDMT
Mitral Valve Anatomy	Appropriate anatomy as defined on TEE	Appropriate anatomy as defined on TEE
Additional Requirements	• Prohibitive surgical risk • Life expectancy > 1 year	• LVEF between 20% and 50% • LVESD ≤ 70 mm • PASP ≤ 70 mmHg
Level of Recommendation	2A	2A

1° (Degenerative) Mitral Regurgitation



2° (Functional) Mitral Regurgitation



MitraClip: Technology

Percutaneous vs. Surgical Intervention

Percutaneous interventions typically emulate and try to **replicate an existing surgical technique**

Percutaneous vs. Surgical Intervention

Mitral clip procedure is a percutaneous emulation of the surgical **edge-to-edge repair (Alfieri stitch)**

Alfieri Edge-to-Edge Stitch Repair

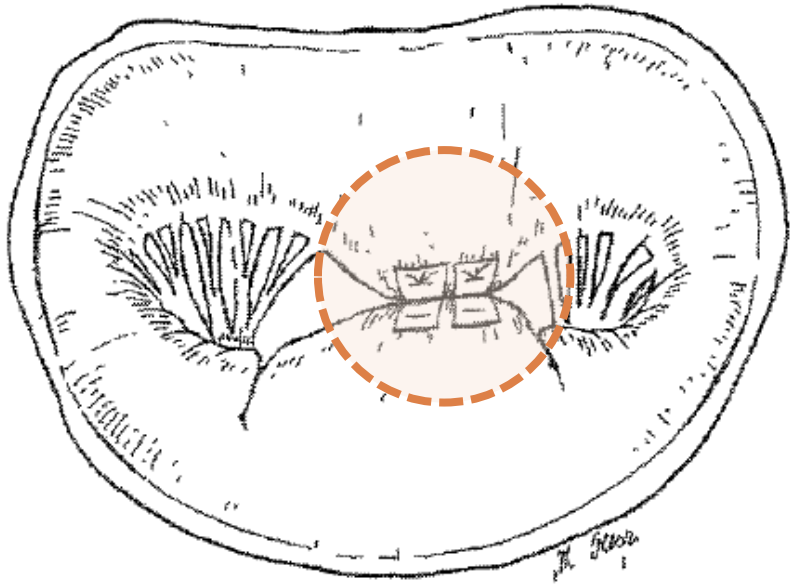
Ottavio Alfieri

b. 1947

Italian Cardiac Surgeon

First conceived in 1991

Pledgeted Sutures at the Site of Mitral Regurgitation (Typically A2/P2)



Alfieri Edge-to-Edge Stitch Repair

June 1991: Alfieri scheduled 2 OR cases on the same day:

Case #1: ASD Repair

Case #2: Mitral valve repair of Barlow's disease

While repairing the ASD, he noted that patient #1 also had something else….

…**congenital** double-orifice mitral valve without significant regurgitation.

He then reasoned that creating an **artificial** dual-orifice mitral valve might eliminate mitral regurgitation in patient #2.

History of Mitral Prolapse & Repair

John Brereton Barlow
South African cardiologist
(1924-2008)

1973
Describes the concept of '**billowing**' of the posterior mitral leaflet

John Michael Criley
American cardiologist
(b. 1931)

1974
Coins the term '**mitral valve prolapse**' while at Hopkins (now at UCLA)

Alain Frédéric Carpentier
French surgeon
(b. 1933)

1983
Develops the surgical '**French correction**'

Ottavio Alfieri
Italian surgeon
(b. 1947)

1991
Surgical **edge-to-edge repair** first performed

Frederick St Goar
American cardiologist
(b. 1957)

1999-2003
Developed the concept of **mitral valve clipping**

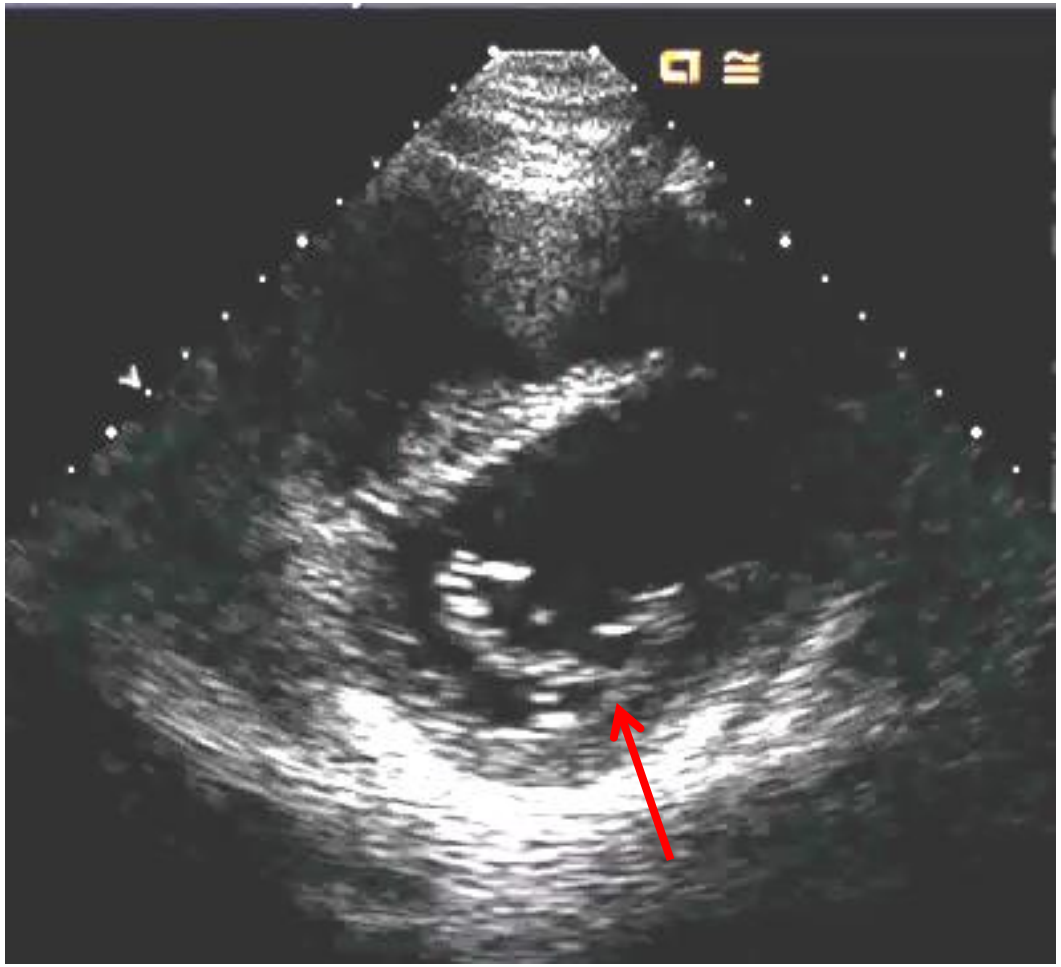
2013
Mitral valve clip **approved by FDA** in the US

Group portrait with Frederick St Gor

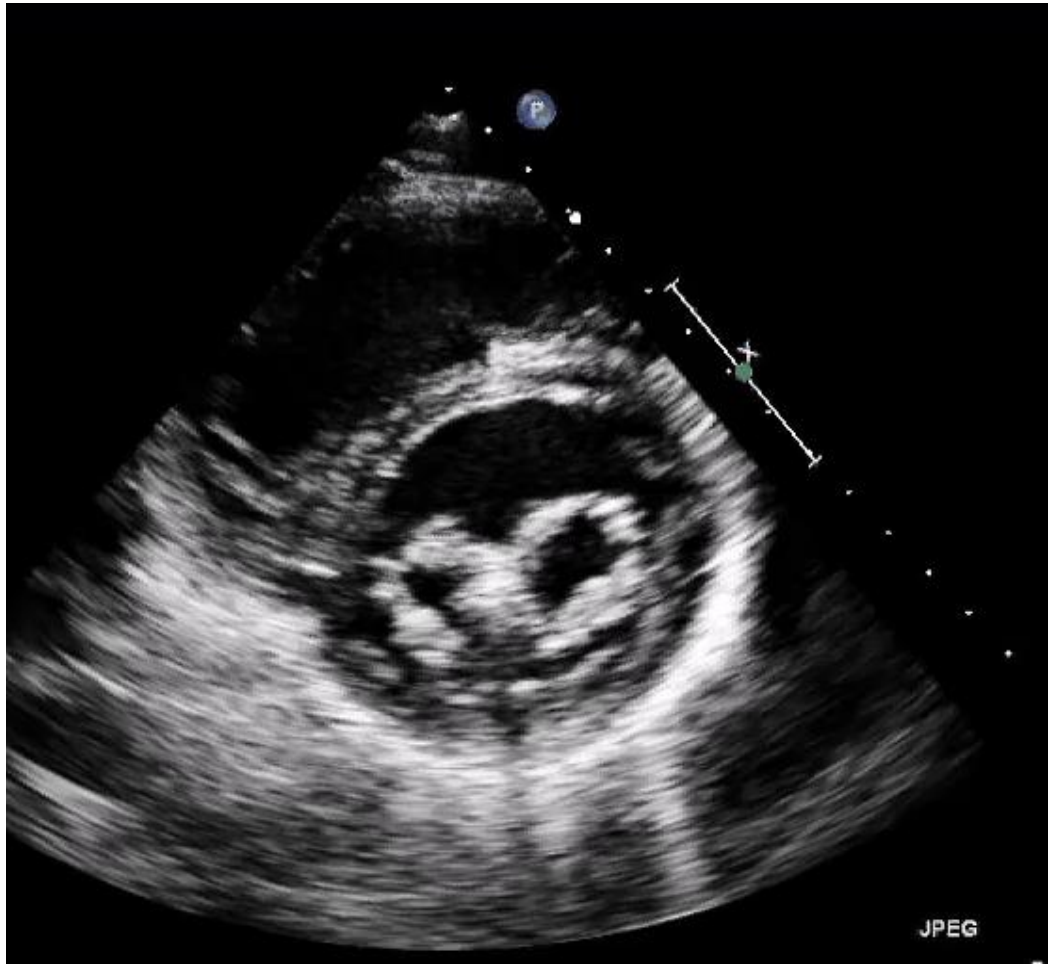
TCT Meeting, Washington, DC

October 29, 2016

Alfieri Stitch vs. Mitral Clip

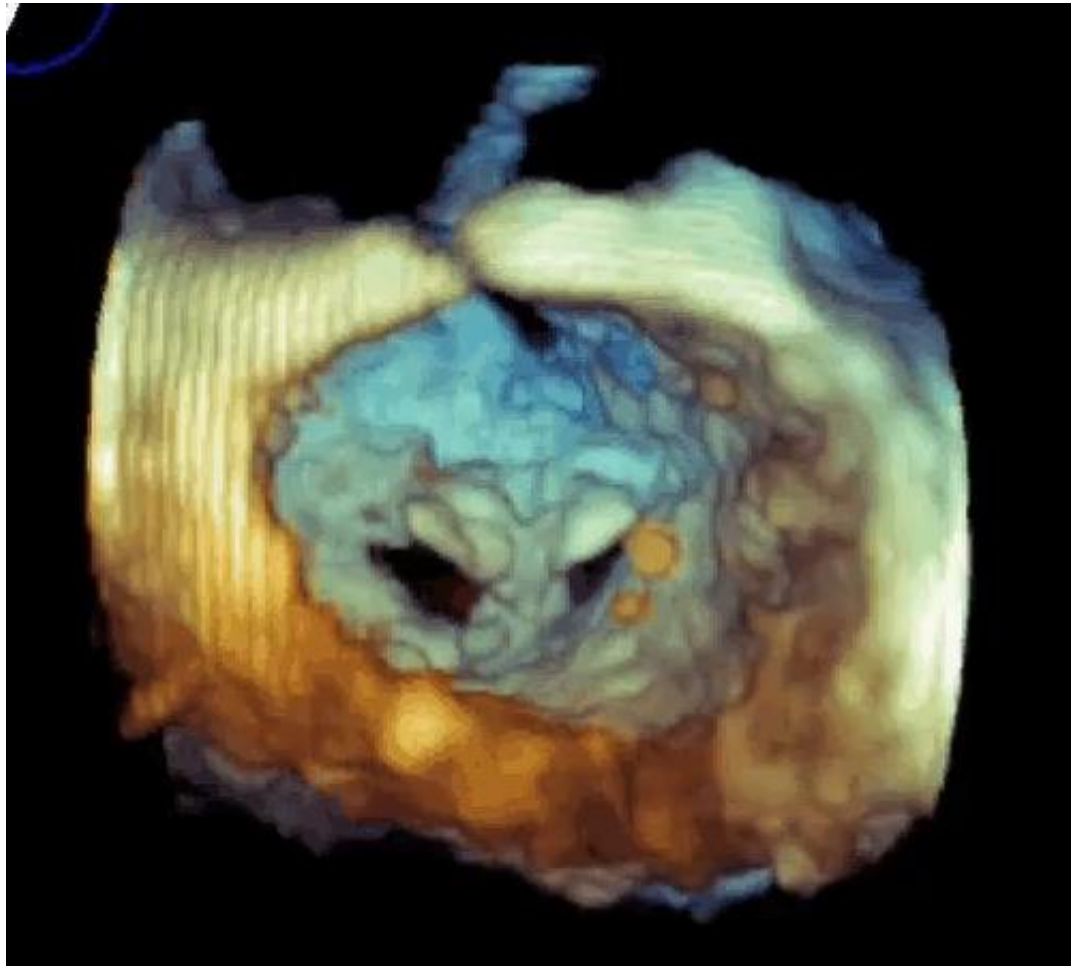


Alfieri Stitch

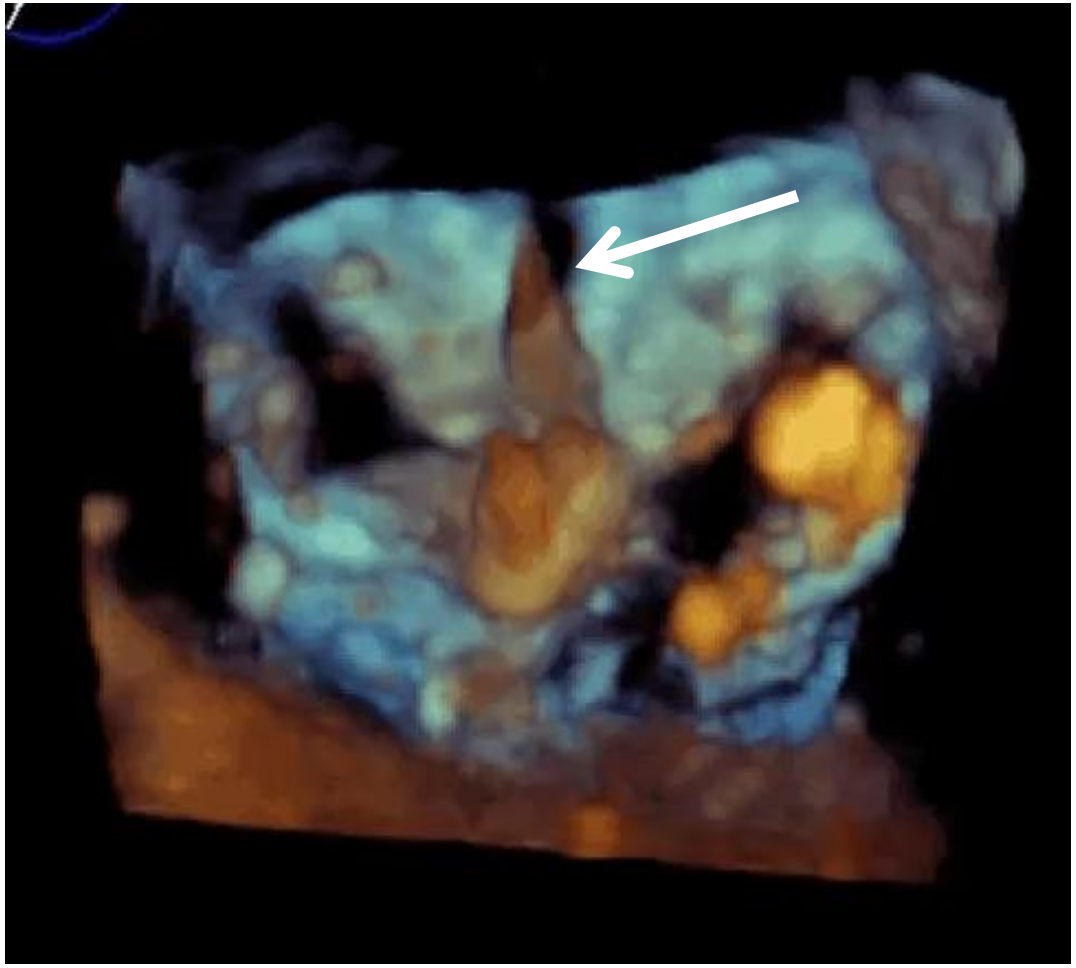


Mitral Clip

Alfieri Stitch vs. Mitral Clip | LV Side



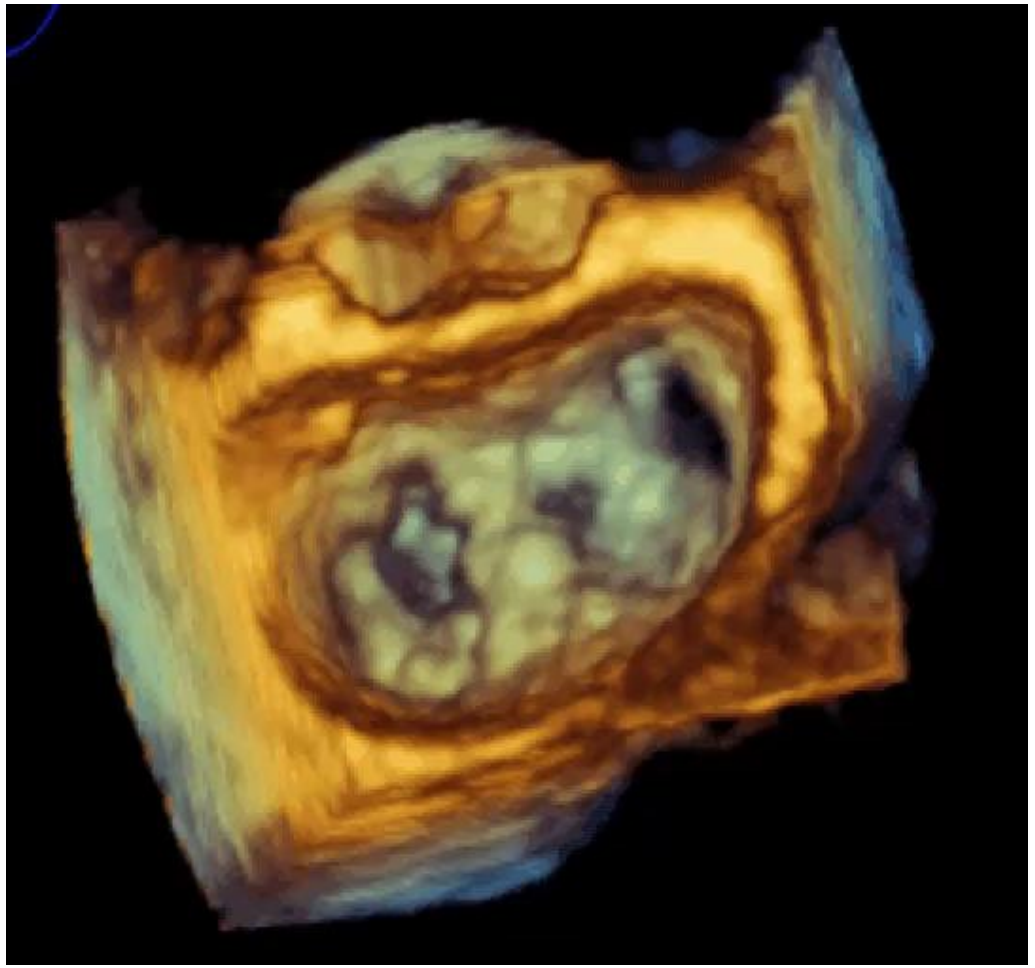
Alfieri Stitch



Mitral Clip

Alfieri Stitch vs. Mitral Clip | LA Side

2 Alfieri Stitches



2 Mitral Clips

Mitral Valve Clipping

Percutaneous, transvenous, transseptal procedure
for treatment of mitral regurgitation
that emulates surgical edge-to-edge repair (Alfieri stitch).

Original Owner
Evalve, Inc.
Menlo Park, CA
(1999-2009)

MITRACLIP®

4-mm wide cobalt chromium
V-shaped clip
covered with polyester cloth

Current Owner
Abbott Vascular
Abbott Park, IL
(since 2009)

Mitral Valve Clipping

Percutaneous, transvenous, transseptal procedure
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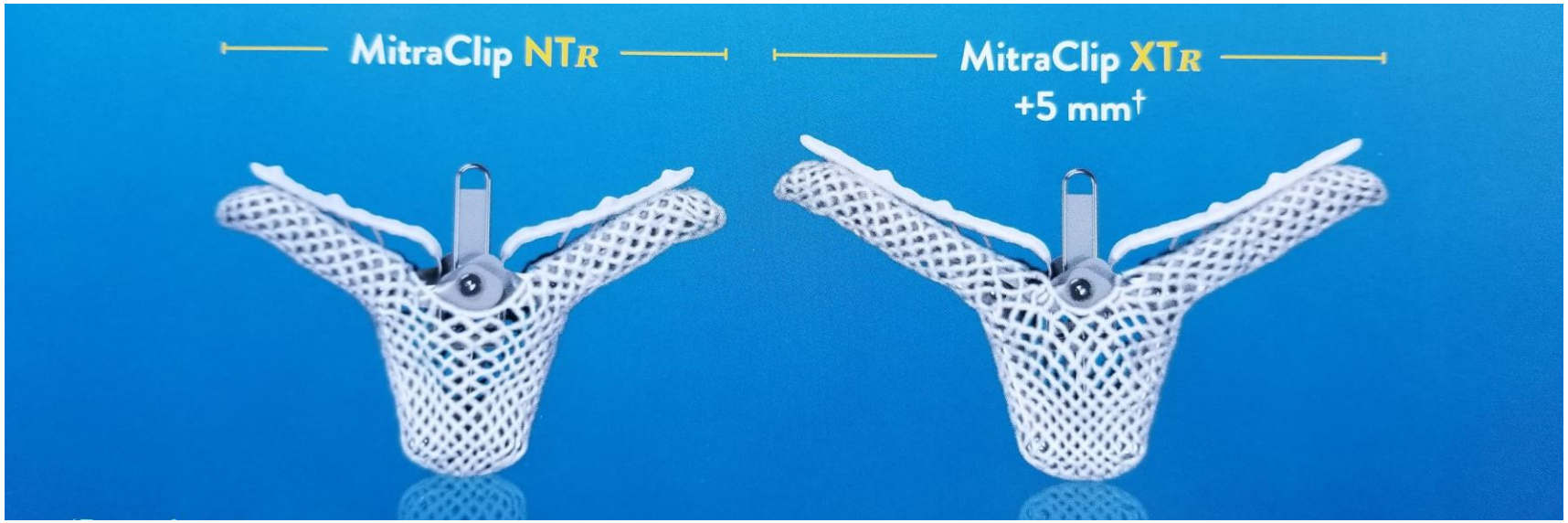


3rd Generations **MitraClip**

Mitral Valve Clipping

Percutaneous, transvenous, transseptal procedure
for treatment of mitral regurgitation
that emulates surgical edge-to-edge repair (Alfieri stitch).

G4 Clips: Width & Height		
	NT	**XT**
Standard	4/15	4/18
Wide	6/15	6/18

Additional G4 System Features

: New guide sheath for live hemodynamics
: Independent grippers
: Simplified clip deployment

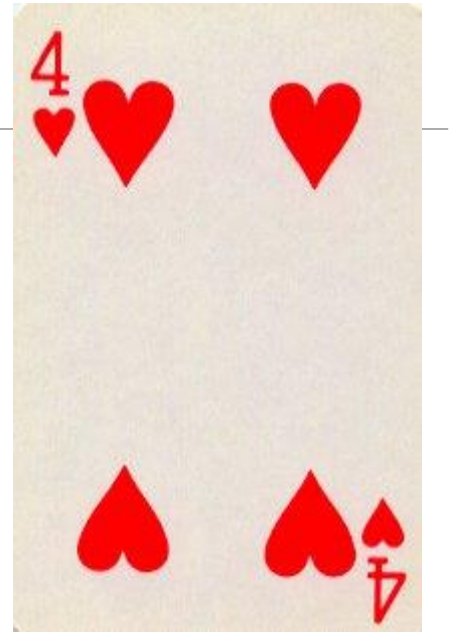
4th Generations **MitraClip**

Clip Guidance

1°	2°
Degenerative Mitral Regurgitation	**Functional** Mitral Regurgitation

Clip TEE Guidance: Degenerative MR

Pre-Clip Echo Evaluation



4 Questions to Answer

- **Q1 : Mitral regurgitation type**
  - Is mitral regurgitation degenerative or functional?
- **Q2: Severity of mitral regurgitation**
  - Is mitral regurgitation at least moderate to severe (3+ or 4+)?
- **Q3: Mitral valve anatomy**
  - Is mitral valve anatomy suitable for clipping?
- **Q4: Contraindication**
  - Are there any general procedural contraindication for this left atrial procedure?

MitraClip® Summary

ECHONOMY
Tools for Echocardiographic Calculations
Muhamed Saric, MD, PhD
New York University

Mitral Clip Screening

Exclusion Criteria

Below are the basic anatomic **exclusion** criteria for mitral valve clipping in addition to the following:

- A2 or P2 calcification in the grasping area or the presence of any significant cleft
- Primary regurgitant jet NOT originating from malcoaptation of the A2 and P2
- Severe mitral annular calcifications
- Mitral stenosis (mitral valve area < 4.0 cm^2)

- LV end-systolic diameter > 5.5 cm
- LVEF ≤ 25%

- Presence of ASD (whether repaired or not) or significant atrial septal aneurysm
- Presence of LA thrombus, vegetation or mass
- Presence of PFO associated with clinical symptoms

Source: **saric.us/echonomy**

Case Presentation

74-year-old man

- Severe degenerative mitral regurgitation due to flail P2
- Recently he noted marked dyspnea on exertion
- Frail, multiple comorbidities
- Referred for percutaneous mitral clip procedure

Case Presentation

74-year-old man

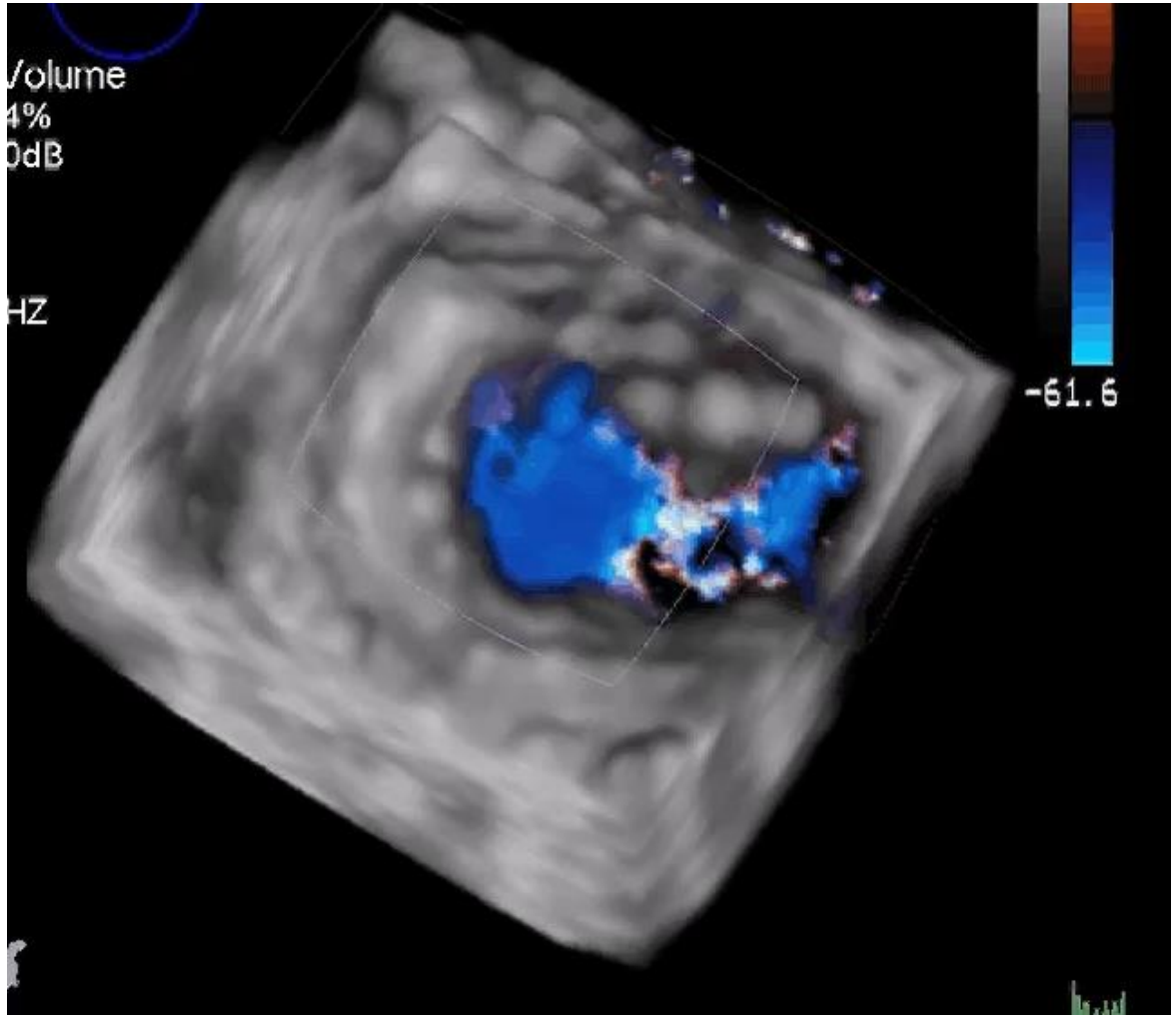
- **Severe degenerative mitral regurgitation** due to flail P2
- Recently he noted marked **dyspnea** on exertion
- **Frail, multiple comorbidities**
- Referred for percutaneous mitral clip procedure

Degenerative MR – Myxomatous Degeneration

74-year-old man
Recent onset of exertional dyspnea

Degenerative MR – Myxomatous Degeneration

74-year-old man
Recent onset of exertional dyspnea



Question

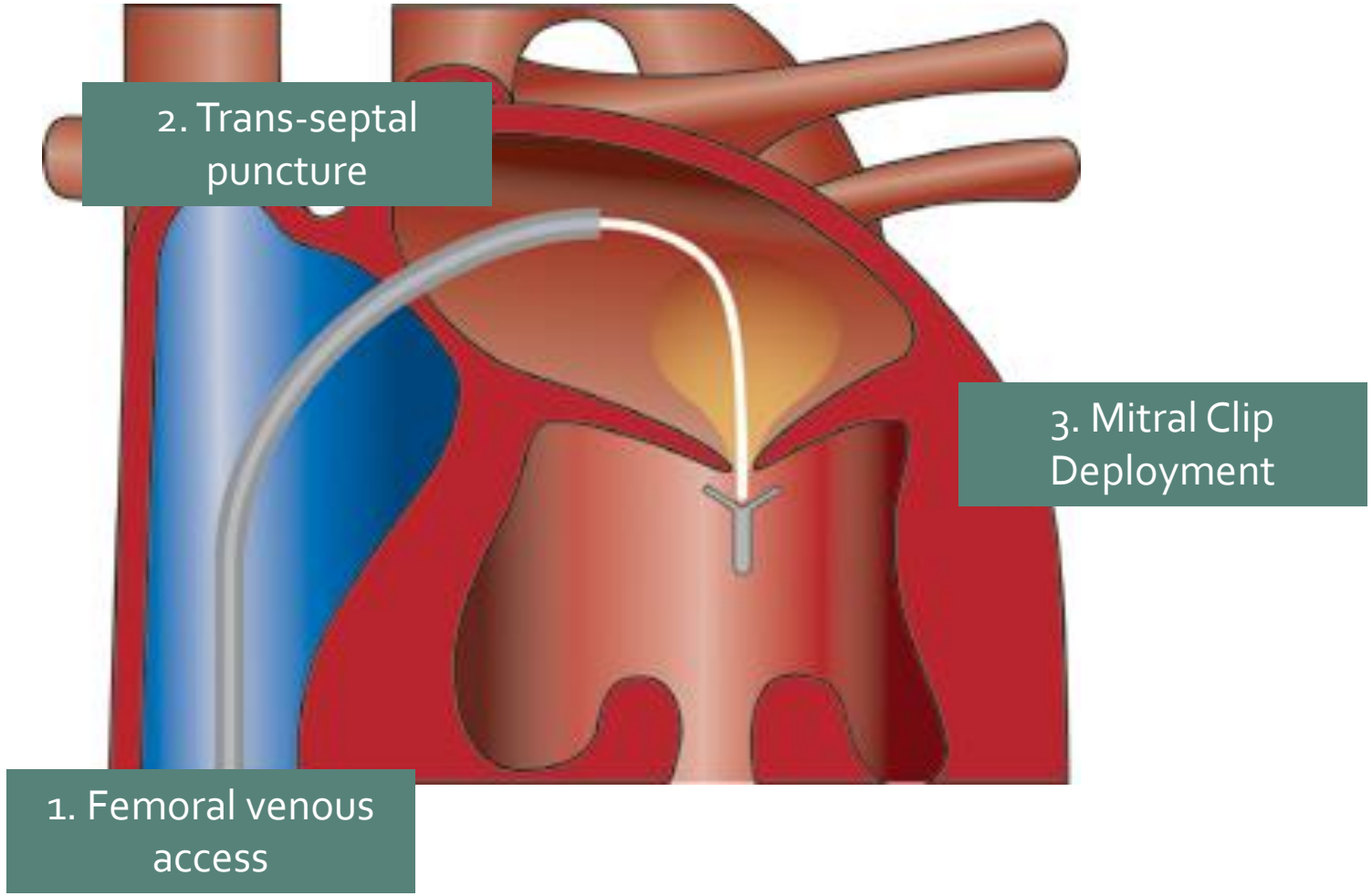
Should this patient undergo mitral clip procedure?

Answer

Because the patient has **severe symptomatic mitral regurgitation** AND is **high surgical risk**…

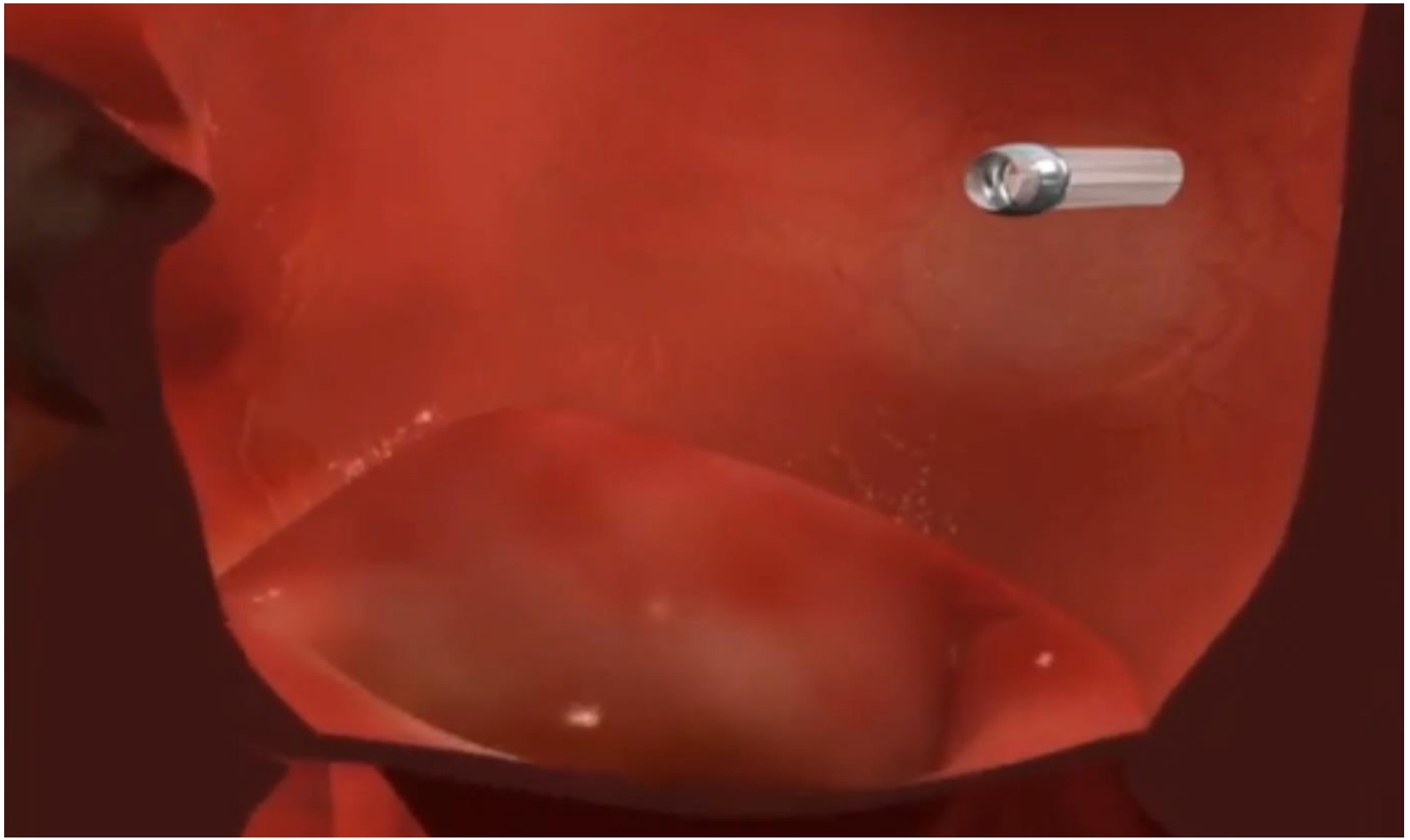
…he should be evaluated for **mitral clip** as he has high surgical risk.

MitraClip® Procedure Overview

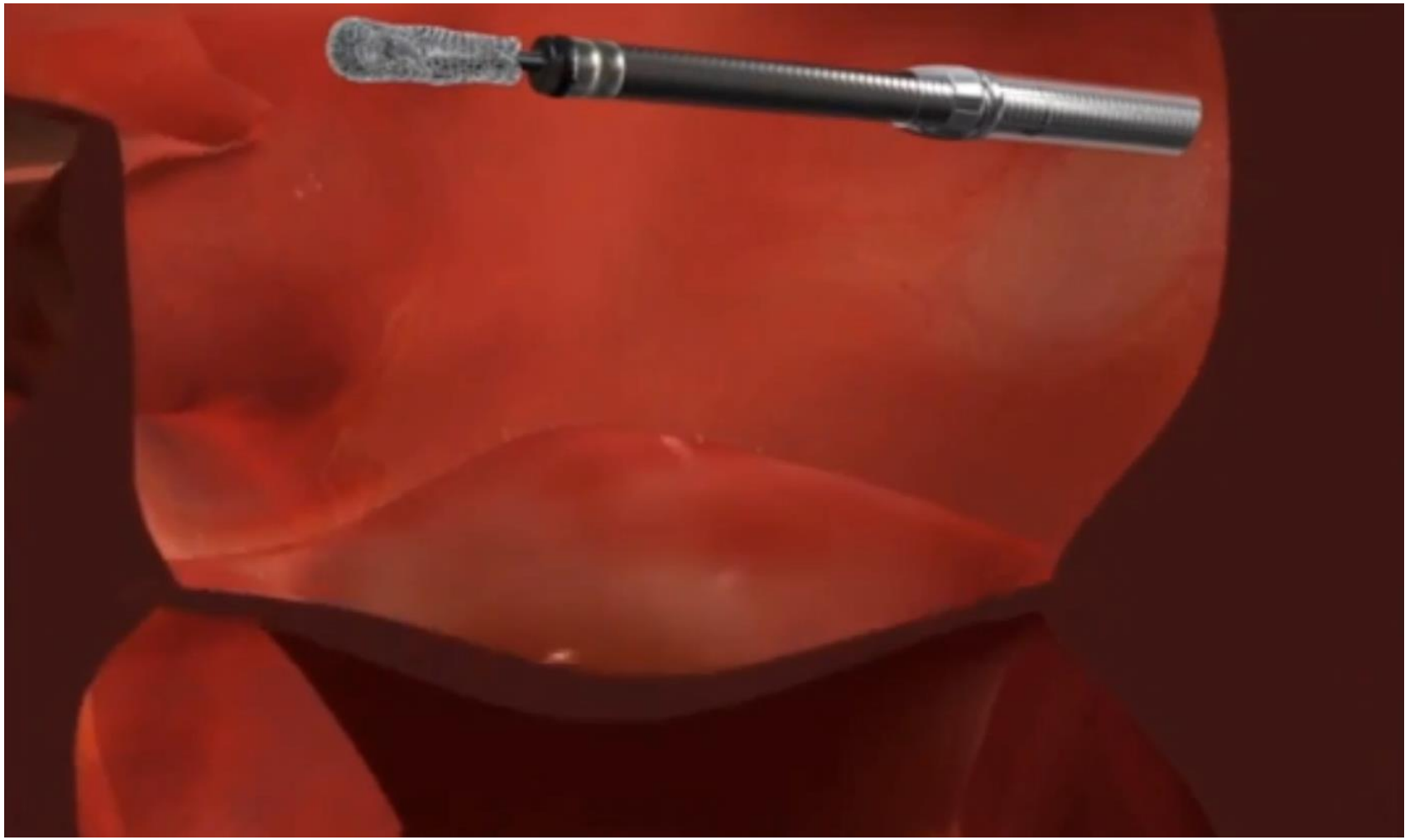


MitraClip® Procedure: Septal Crossing of Guide Catheter

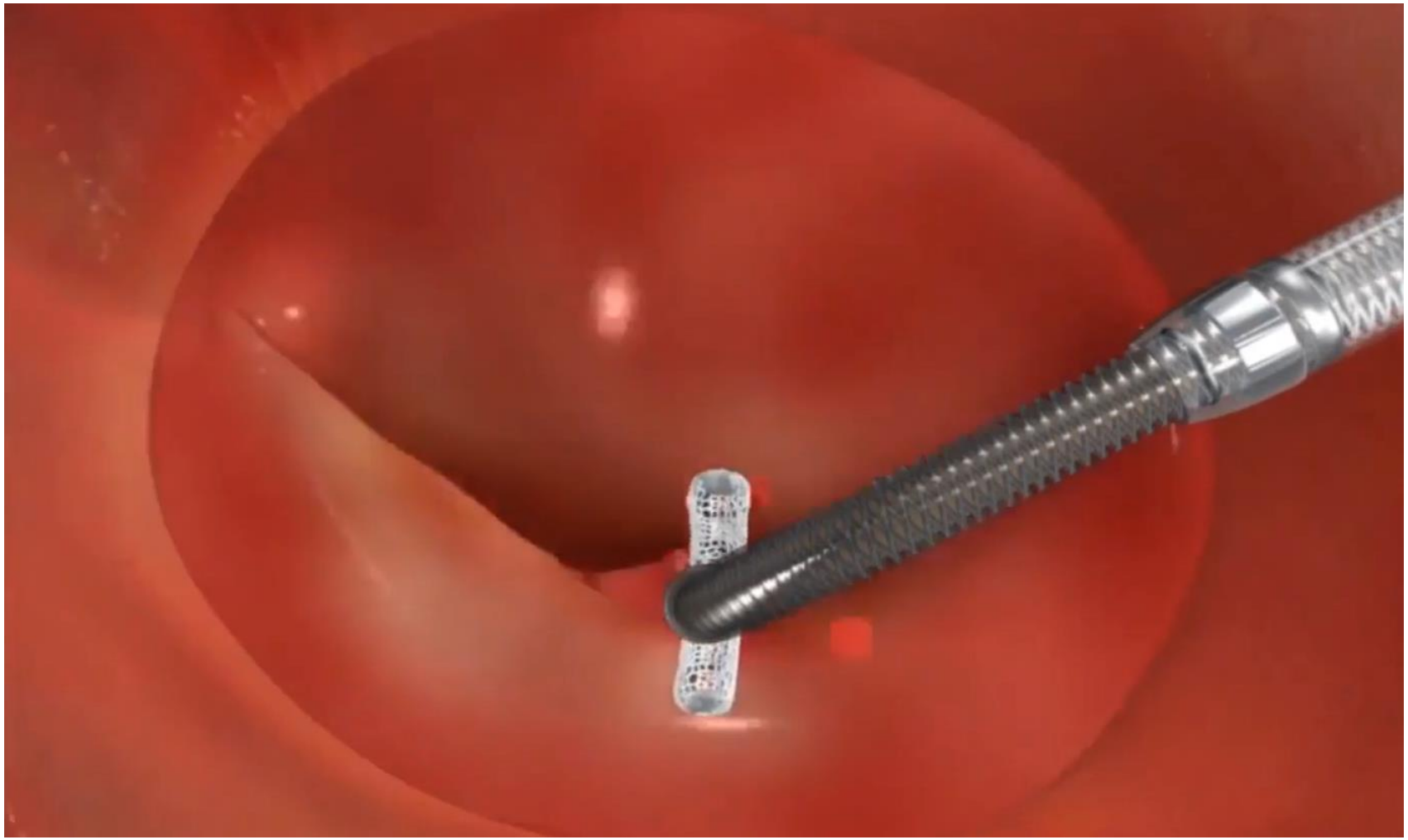
MitraClip® Procedure: Introduction of Clip Delivery System



MitraClip® Procedure: Positioning of Clip Delivery System



MitraClip® Procedure: Leaflet Grasping



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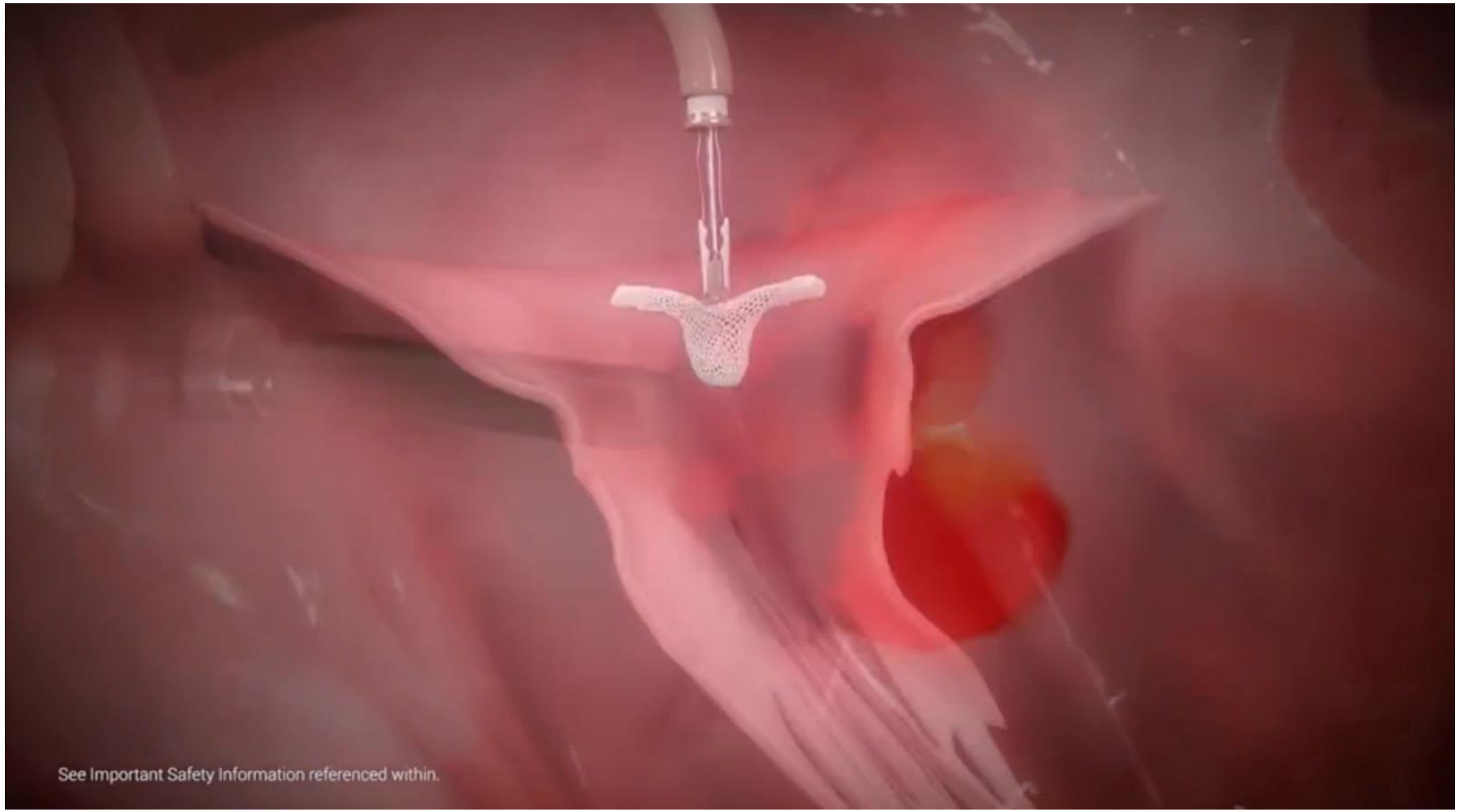

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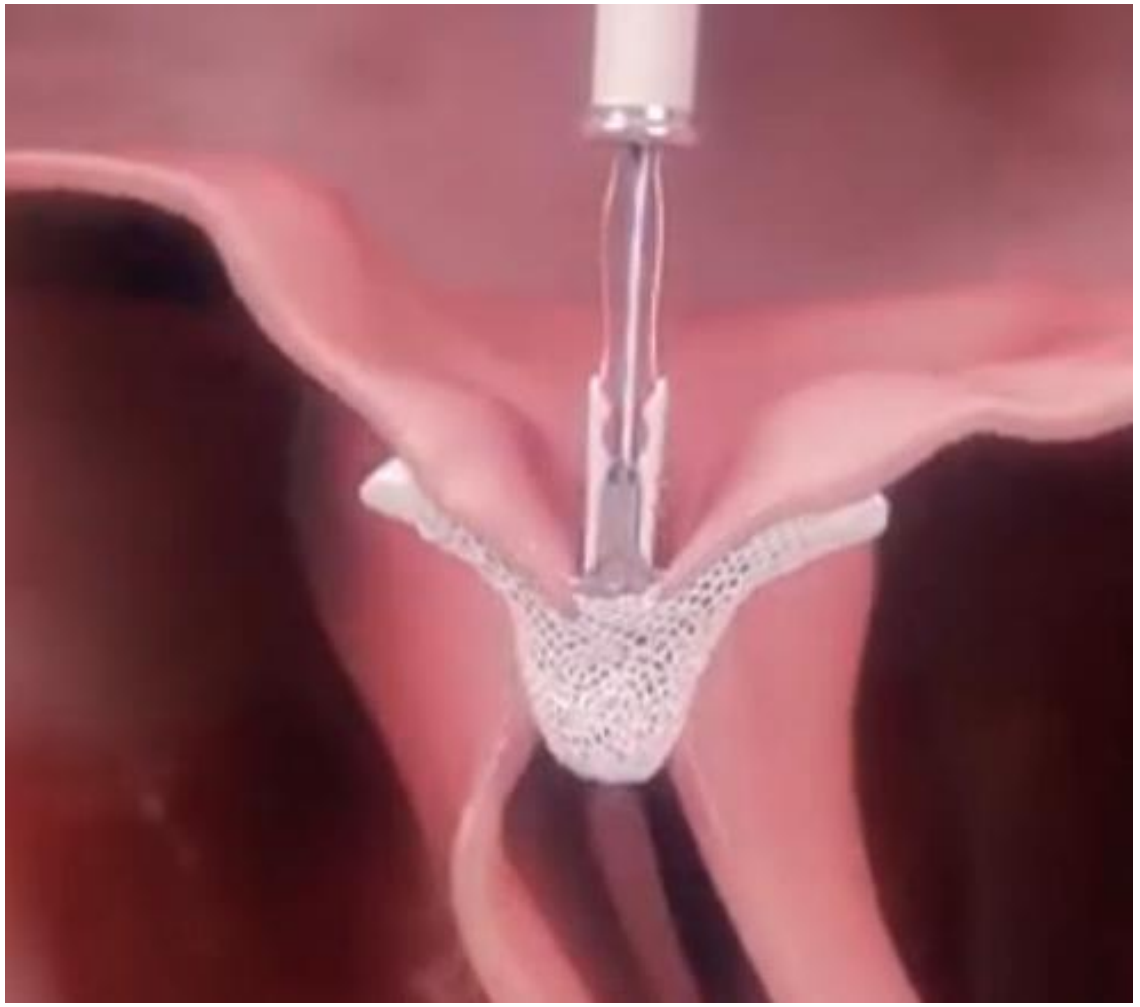

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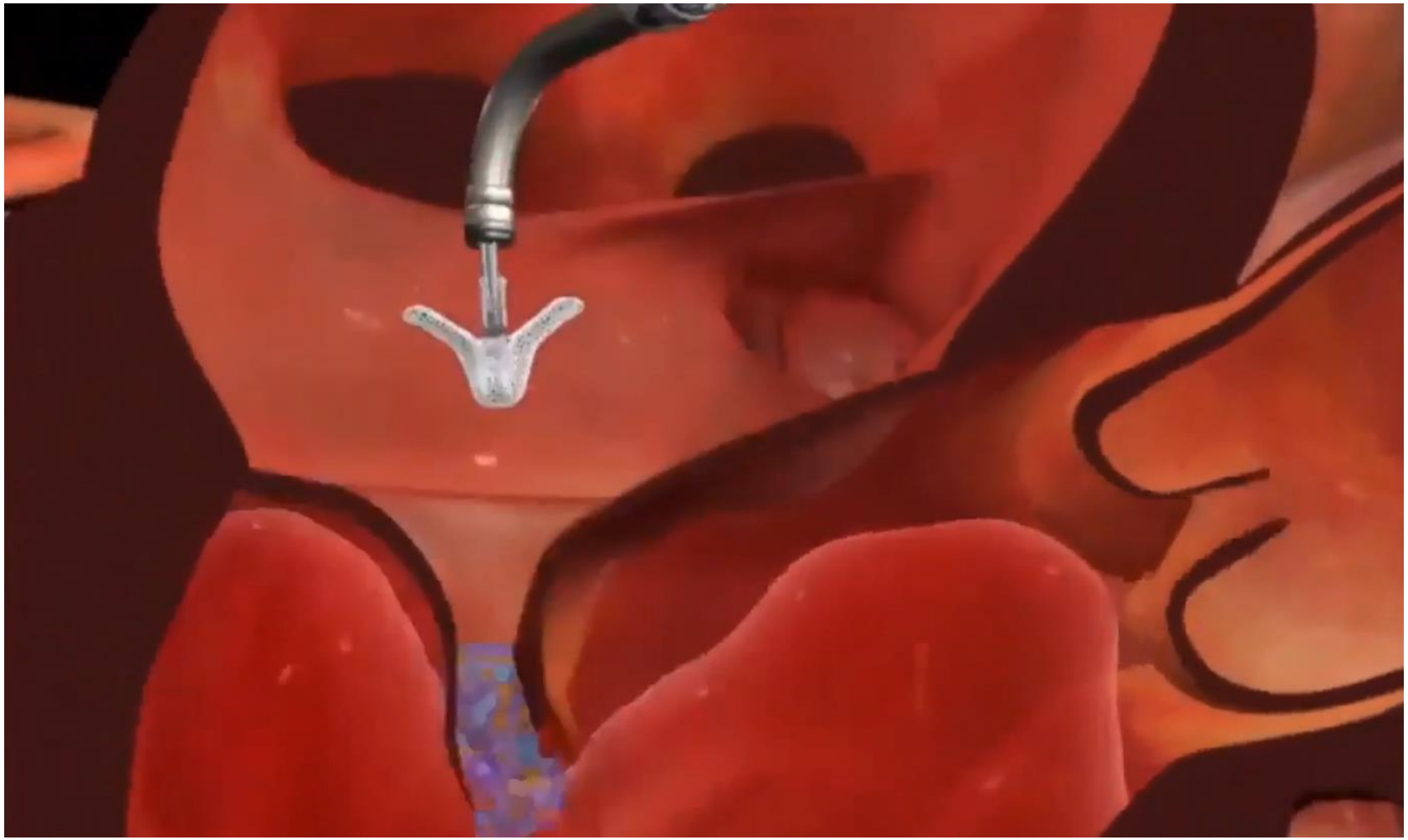
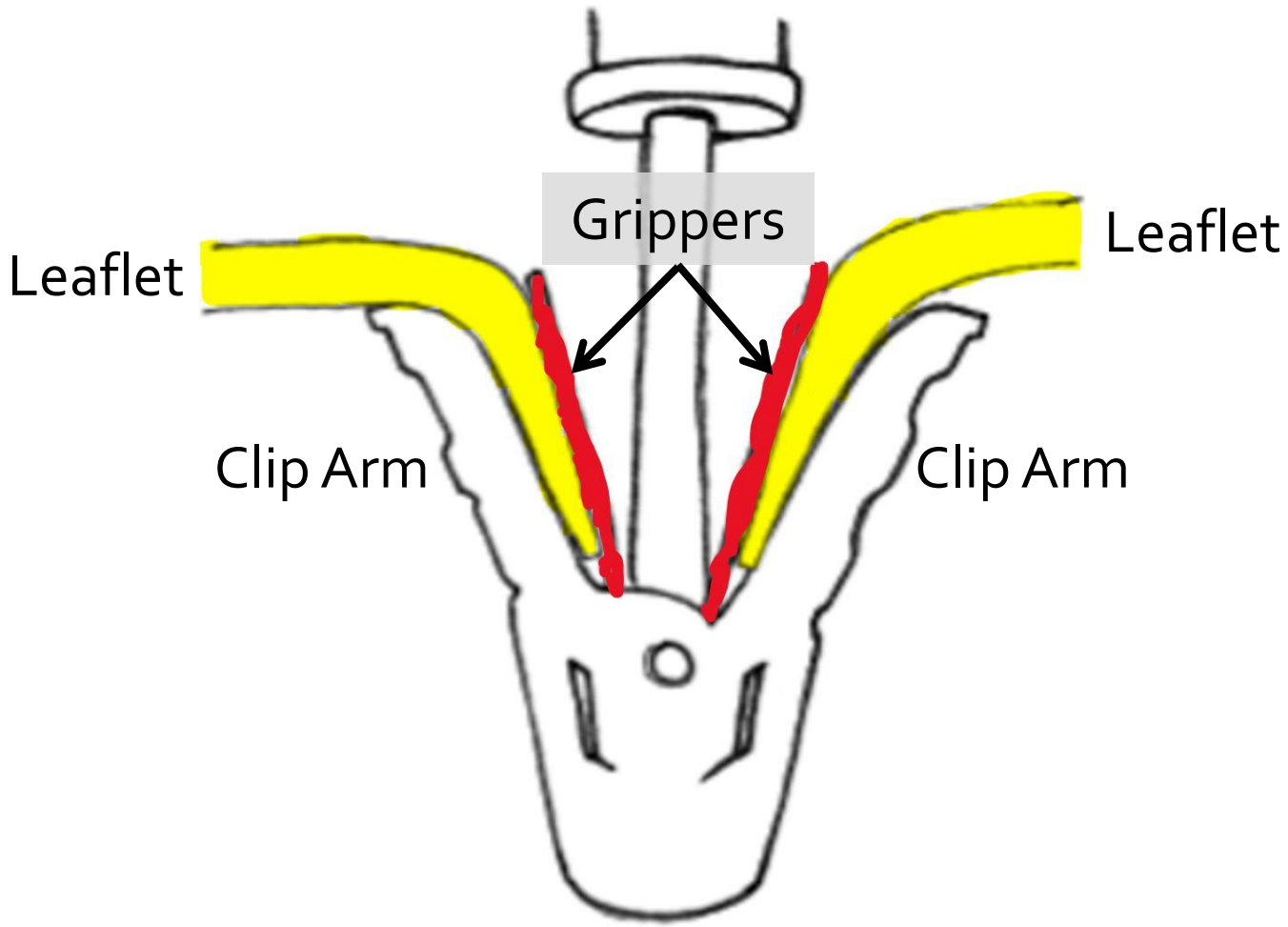
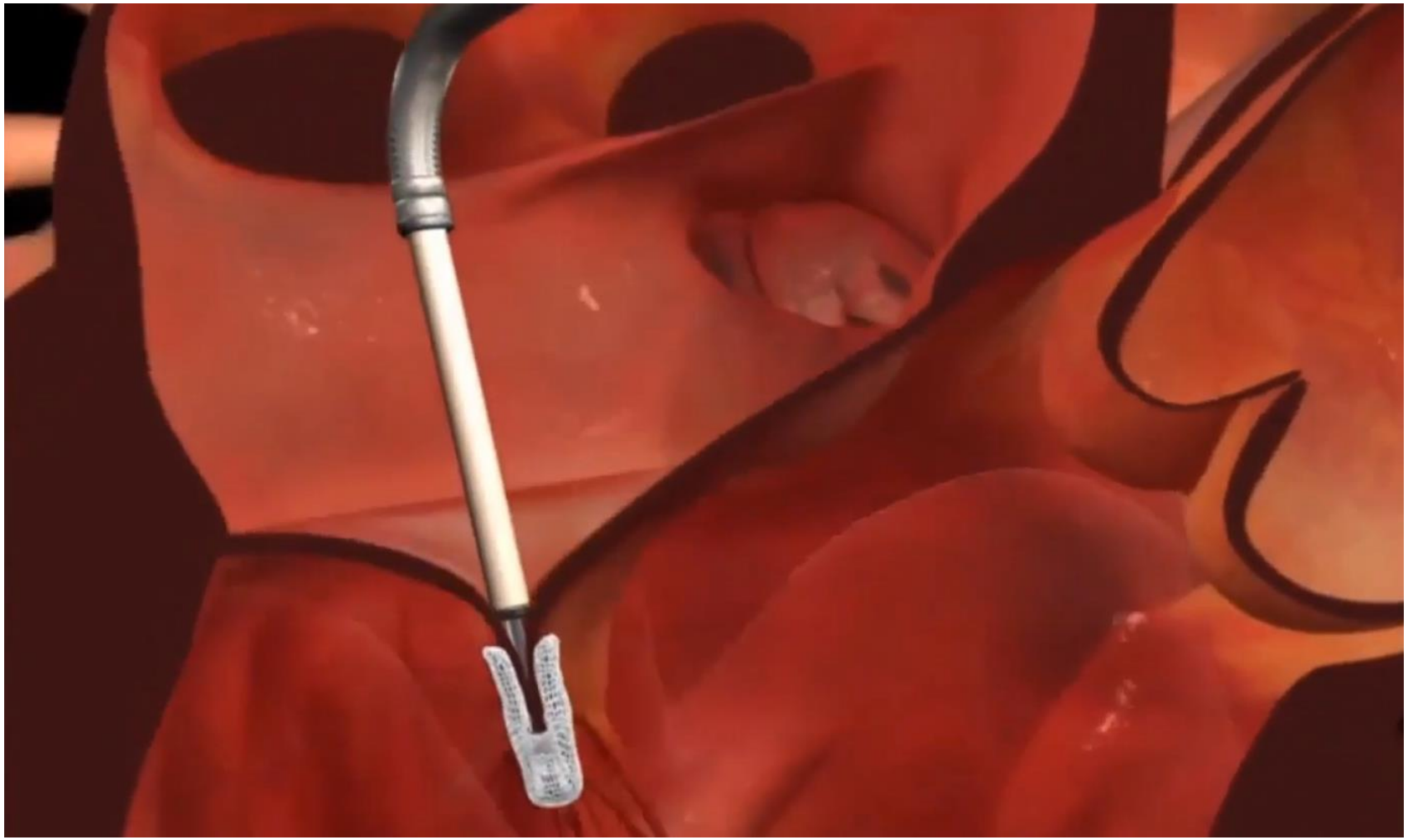


MitraClip® Procedure: Leaflet Grasping

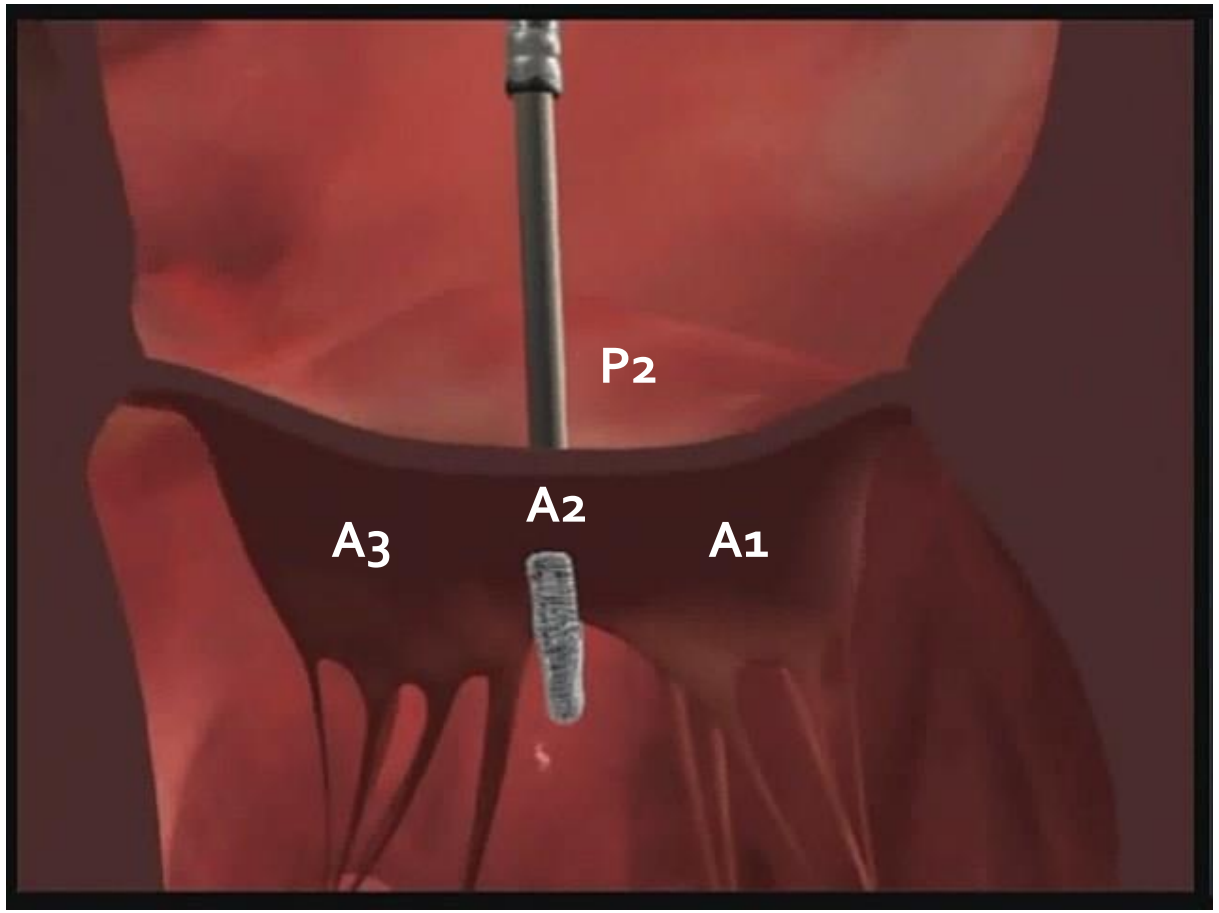
MitraClip® Procedure: Grasping



MitraClip® Procedure: Clip Deployment



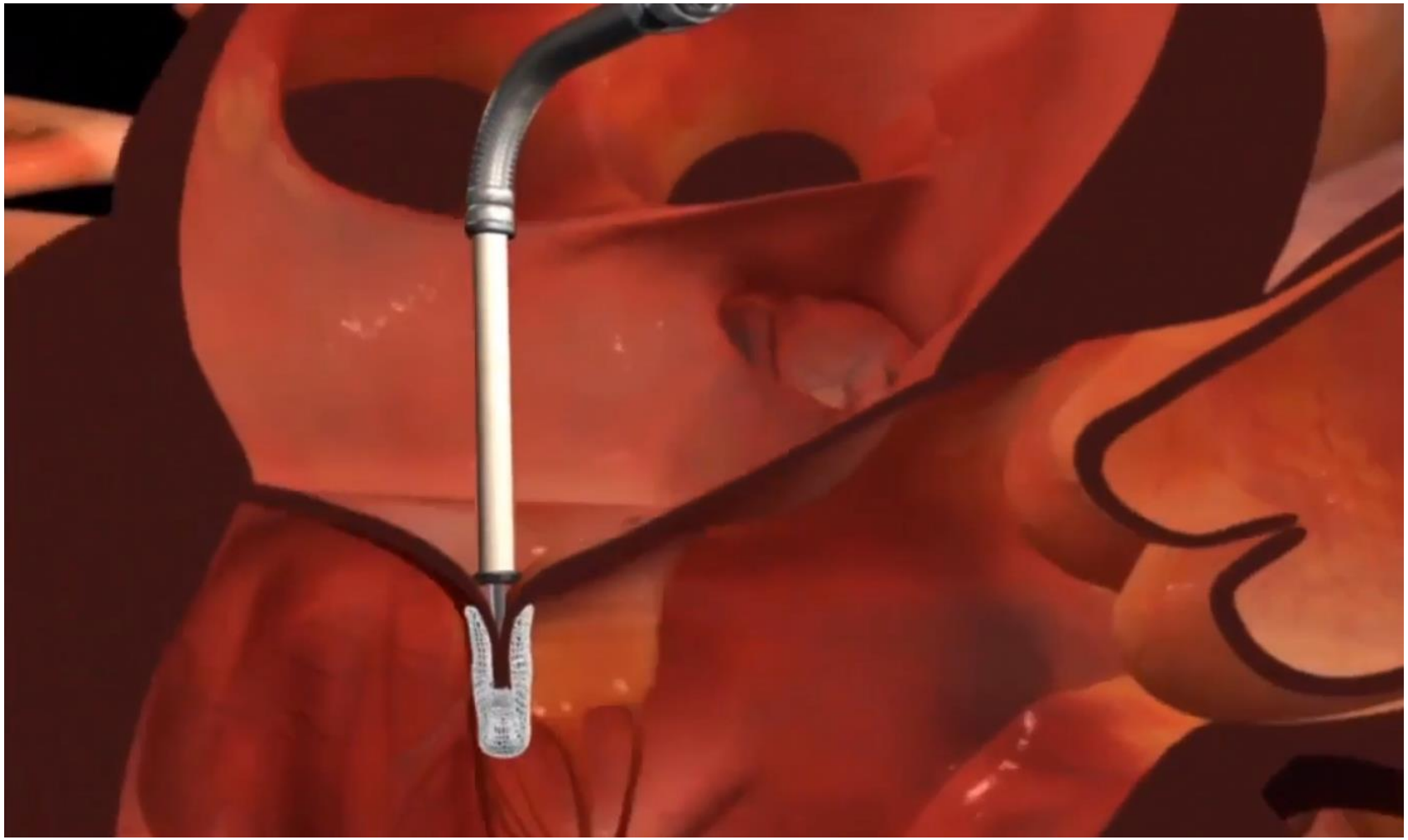
MitraClip® Procedure: Deployment



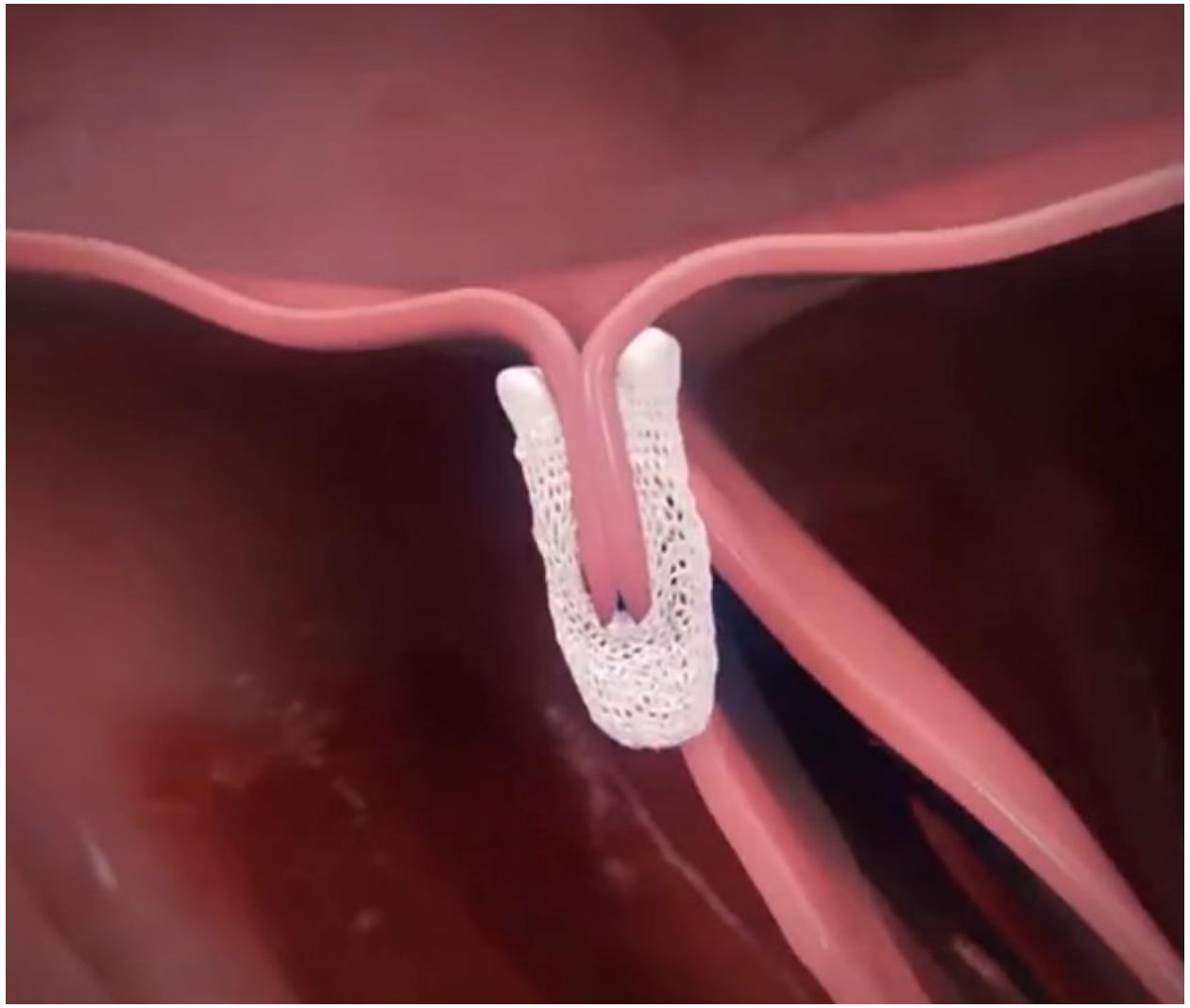
Note the relative **absence** of chordae in the **A2/P2** region

This makes **A2/P2** region the ideal place for mitral clipping.

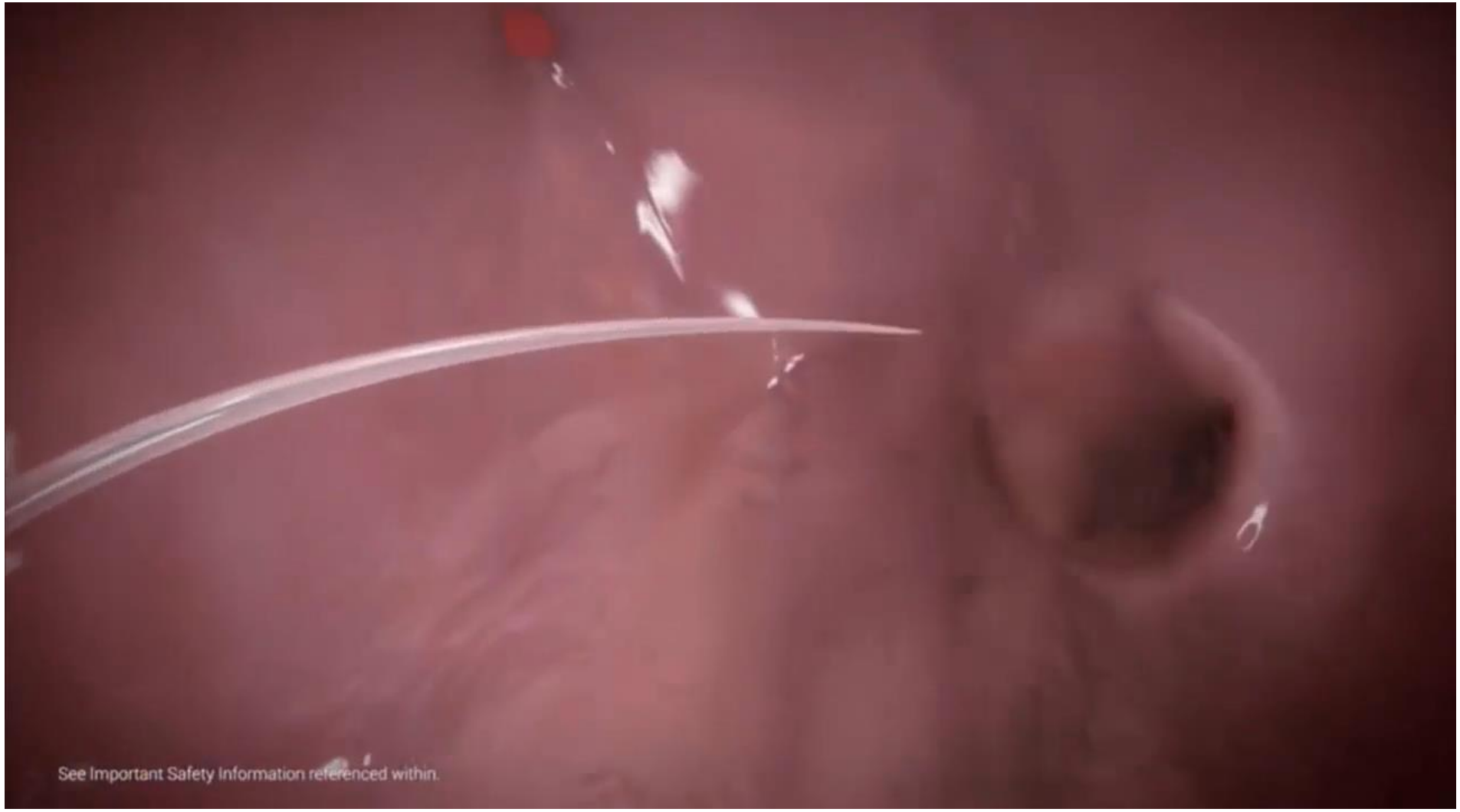
MitraClip® Procedure: Clip Release



MitraClip® Procedure: Clip Endothelialization

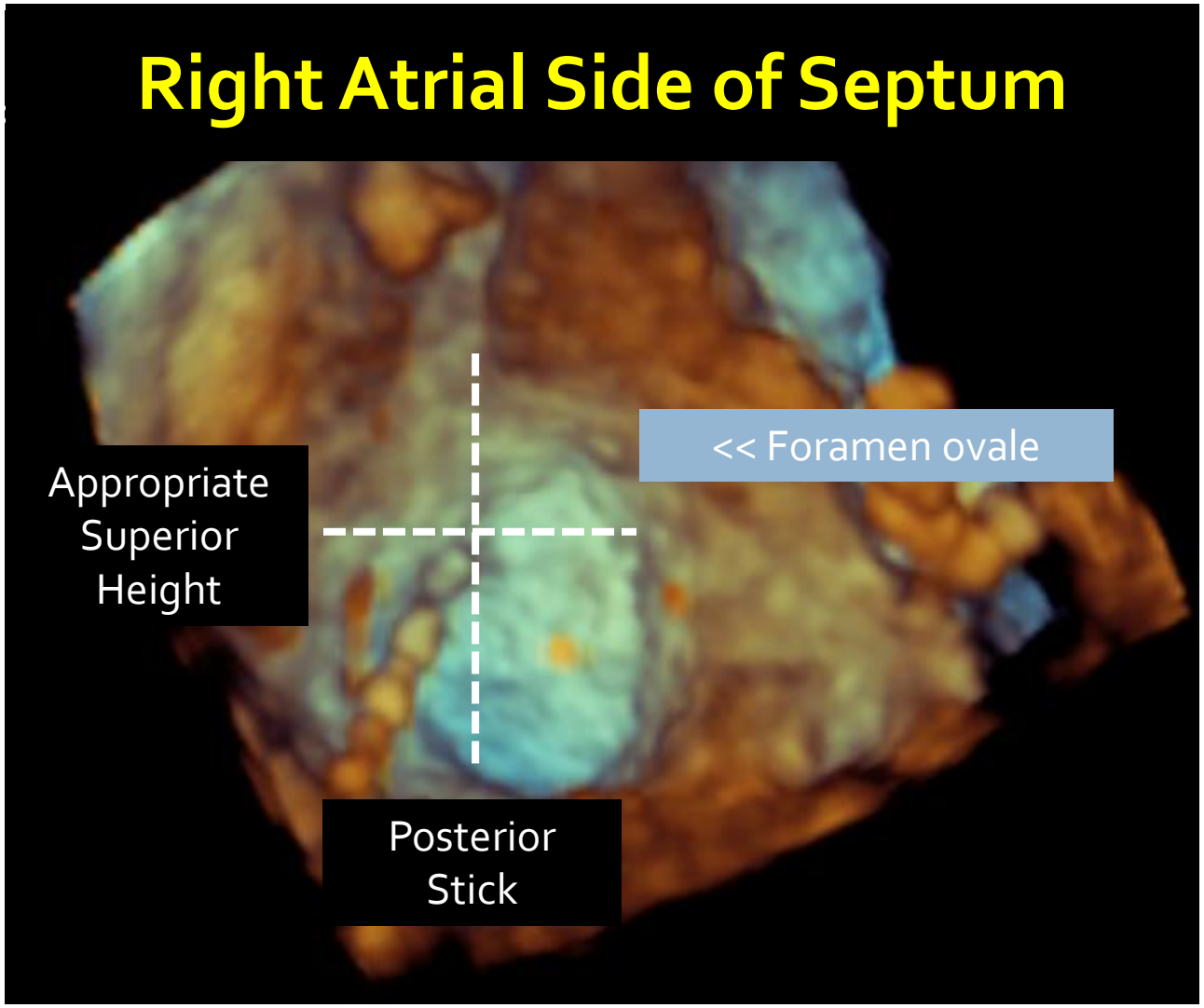


MitraClip® Animation Sped Up

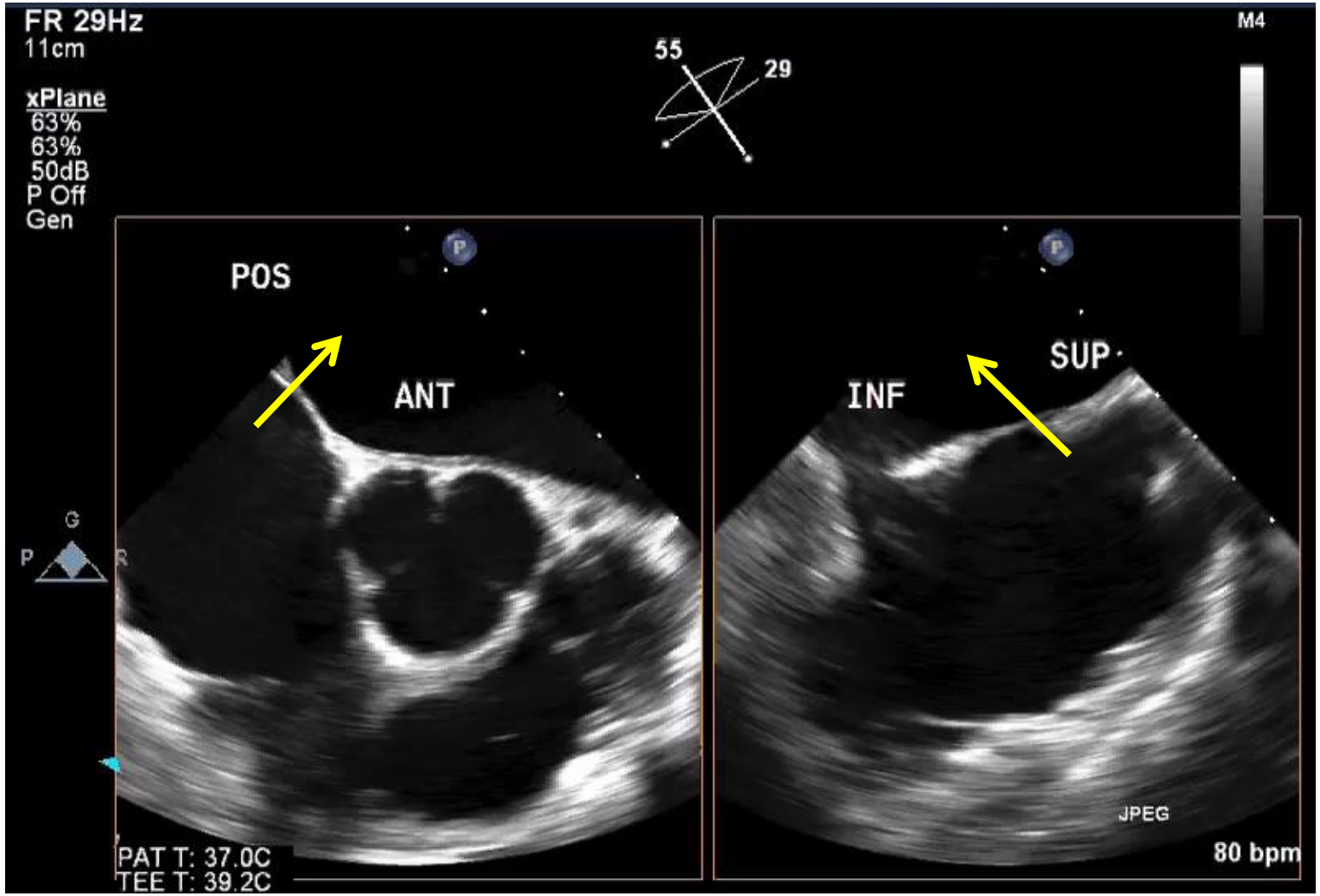


Transeptal Puncture

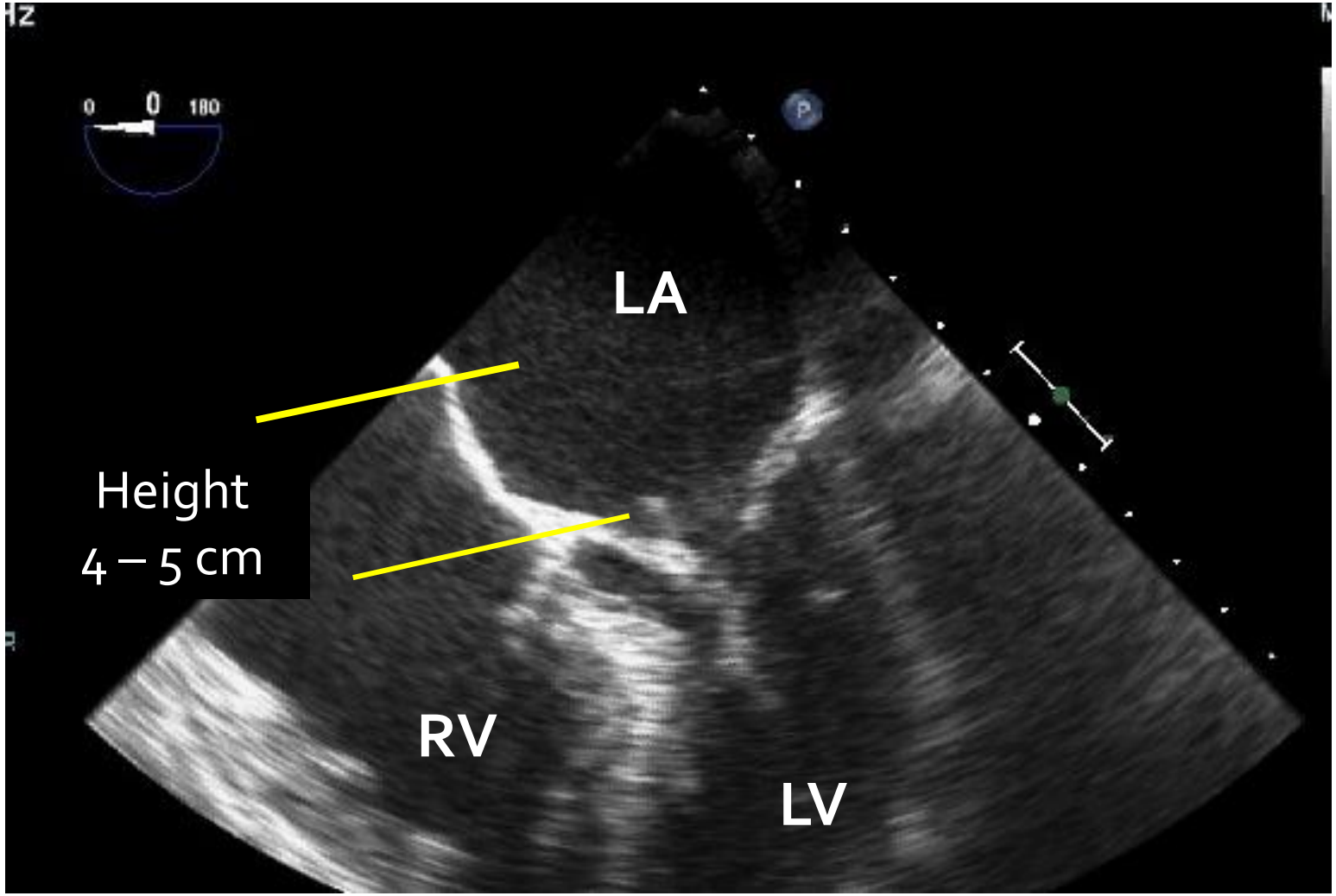
Transeptal Puncture for Mitral Clip



Transeptal Guidance by Biplane TEE

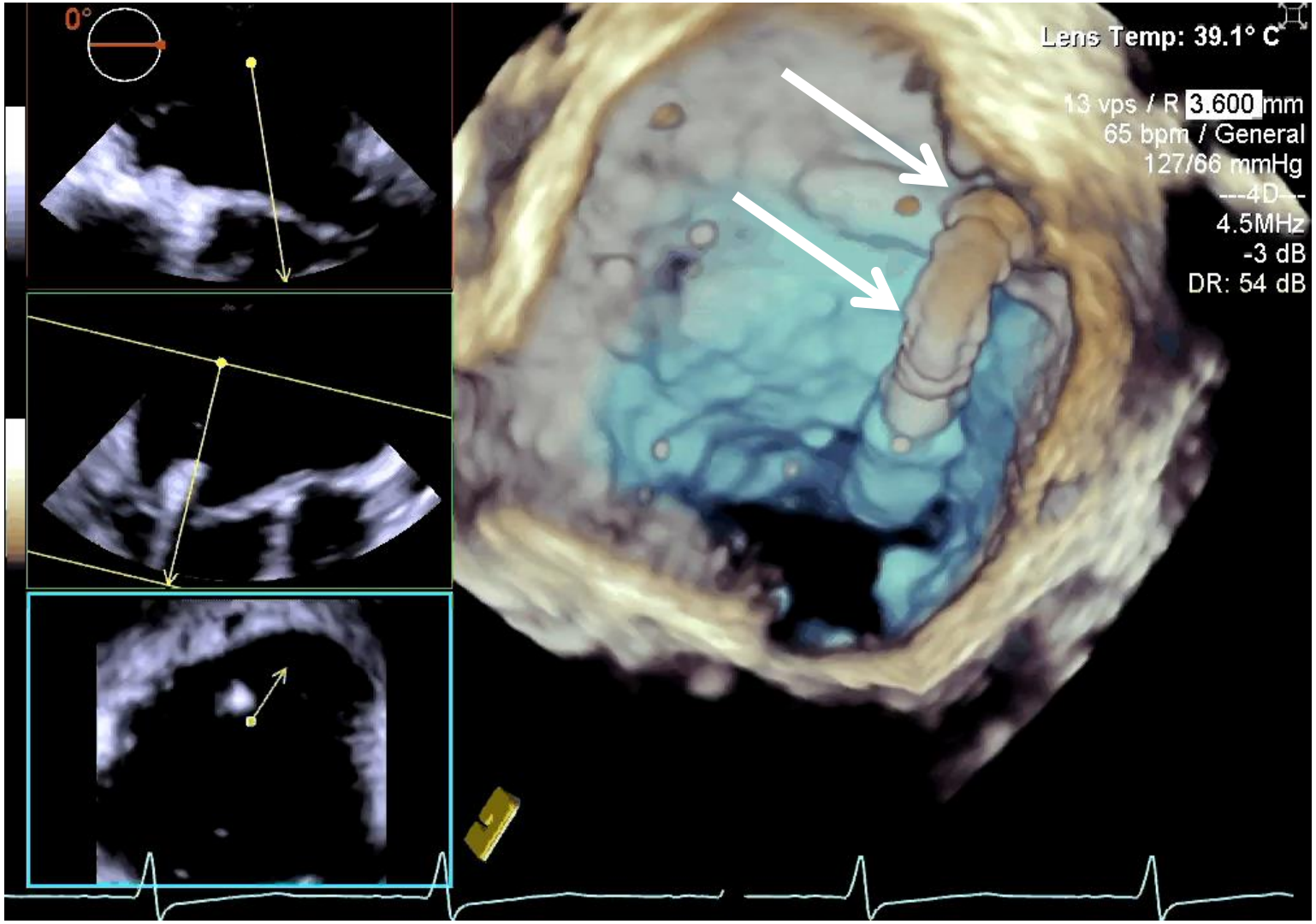


Transeptal Guidance by TEE

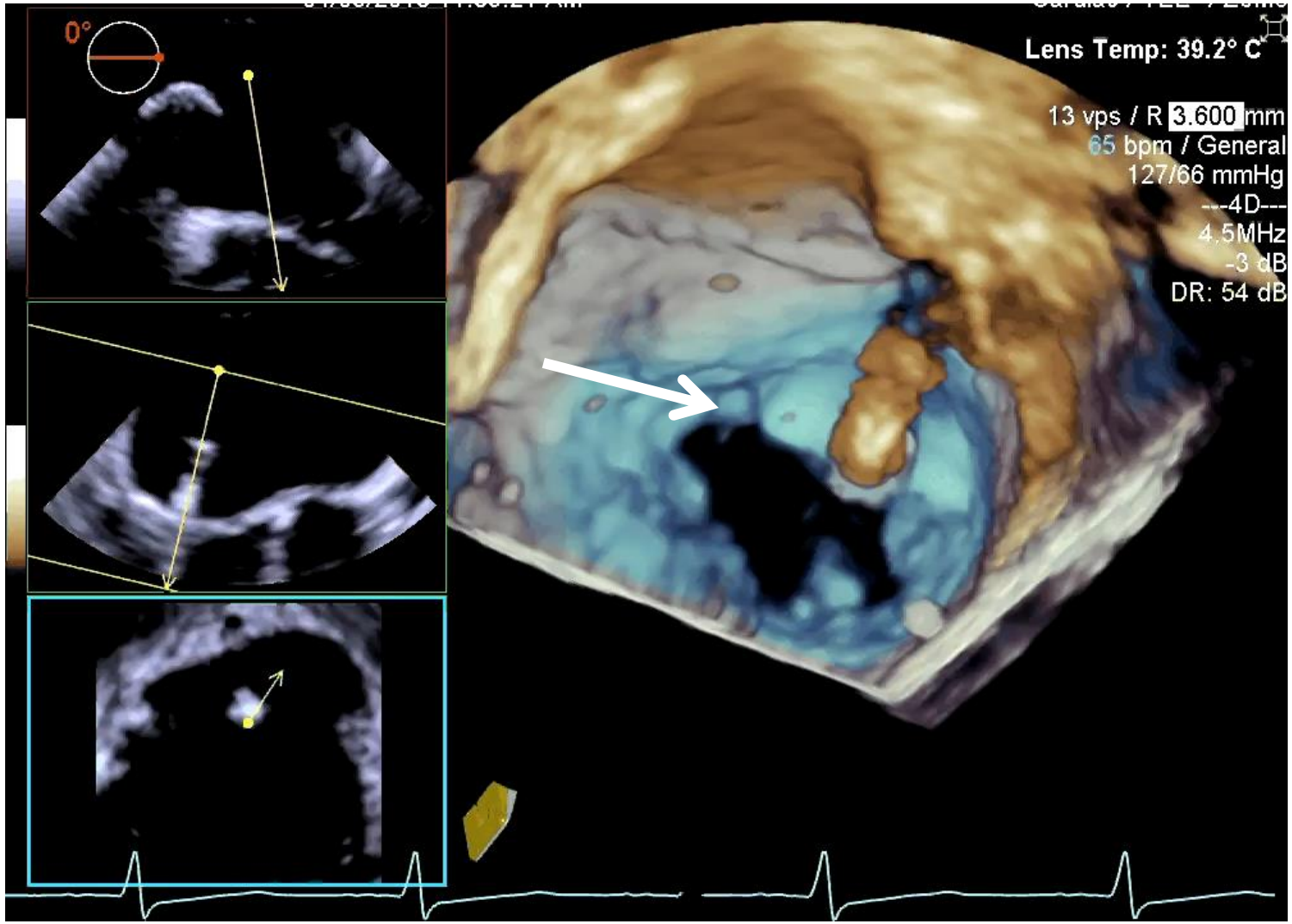


Clip Implantation Guidance

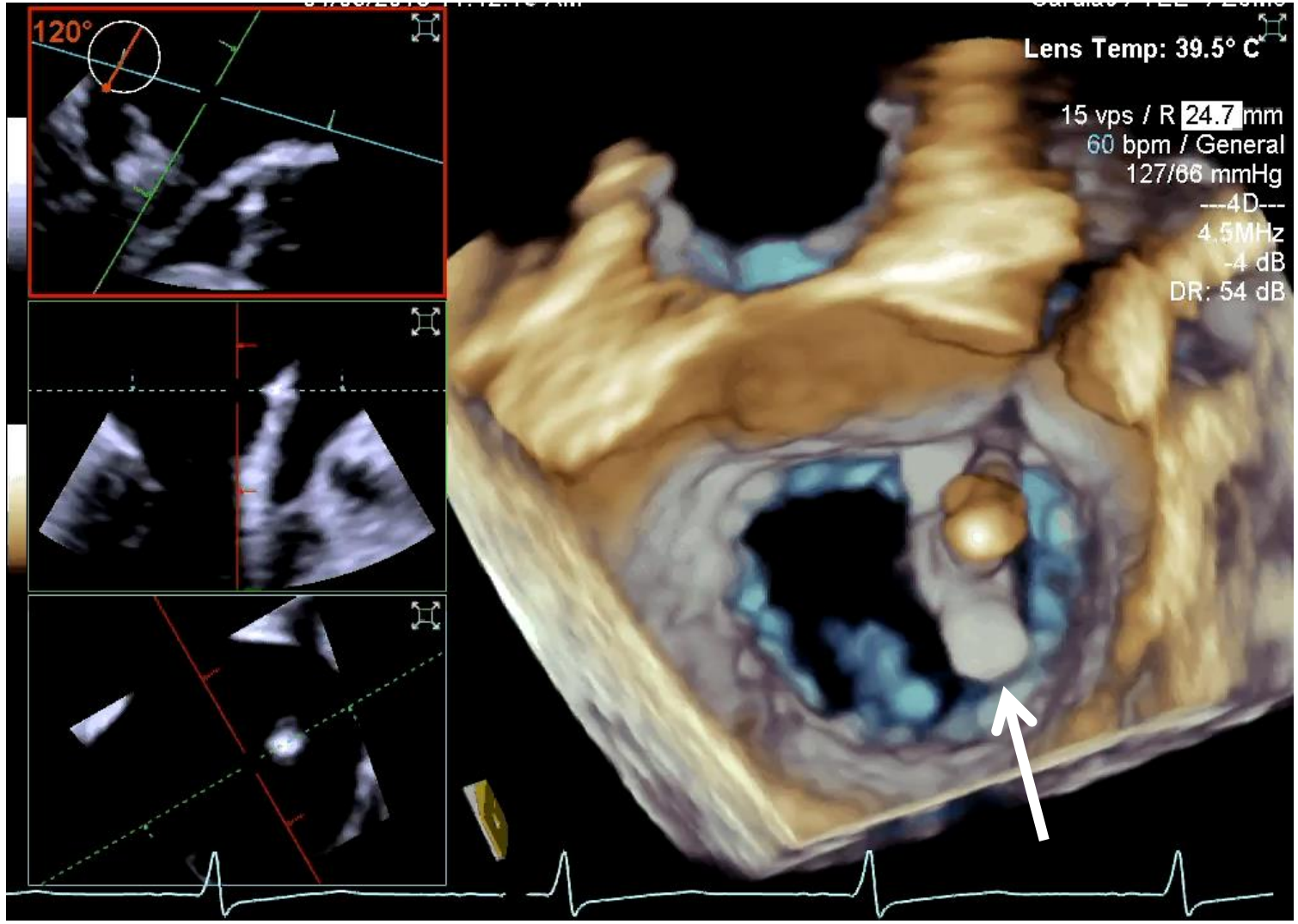
Clip Guidance: Delivery Sheath in LA



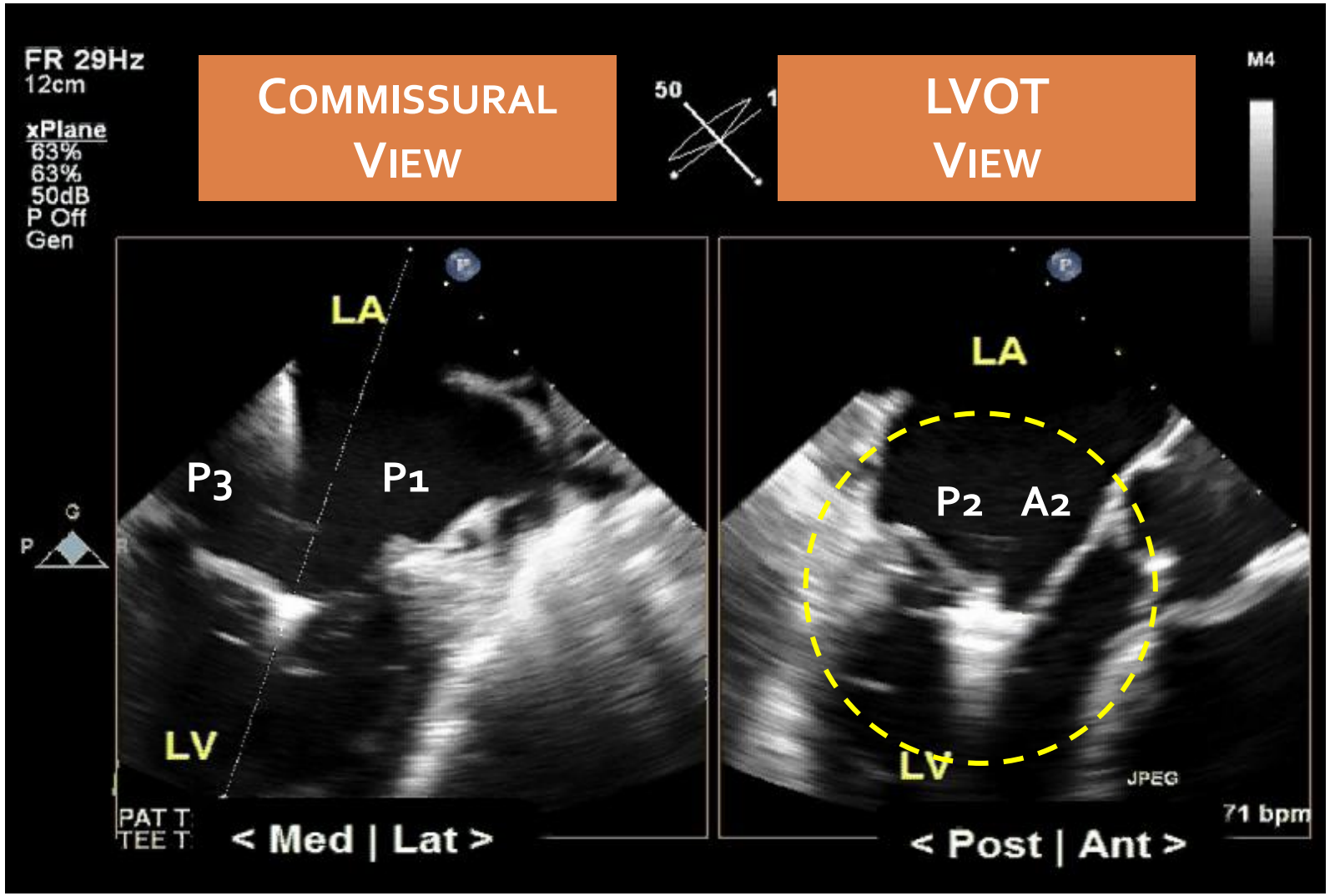
Clip Guidance: Clip Arms Open in LA



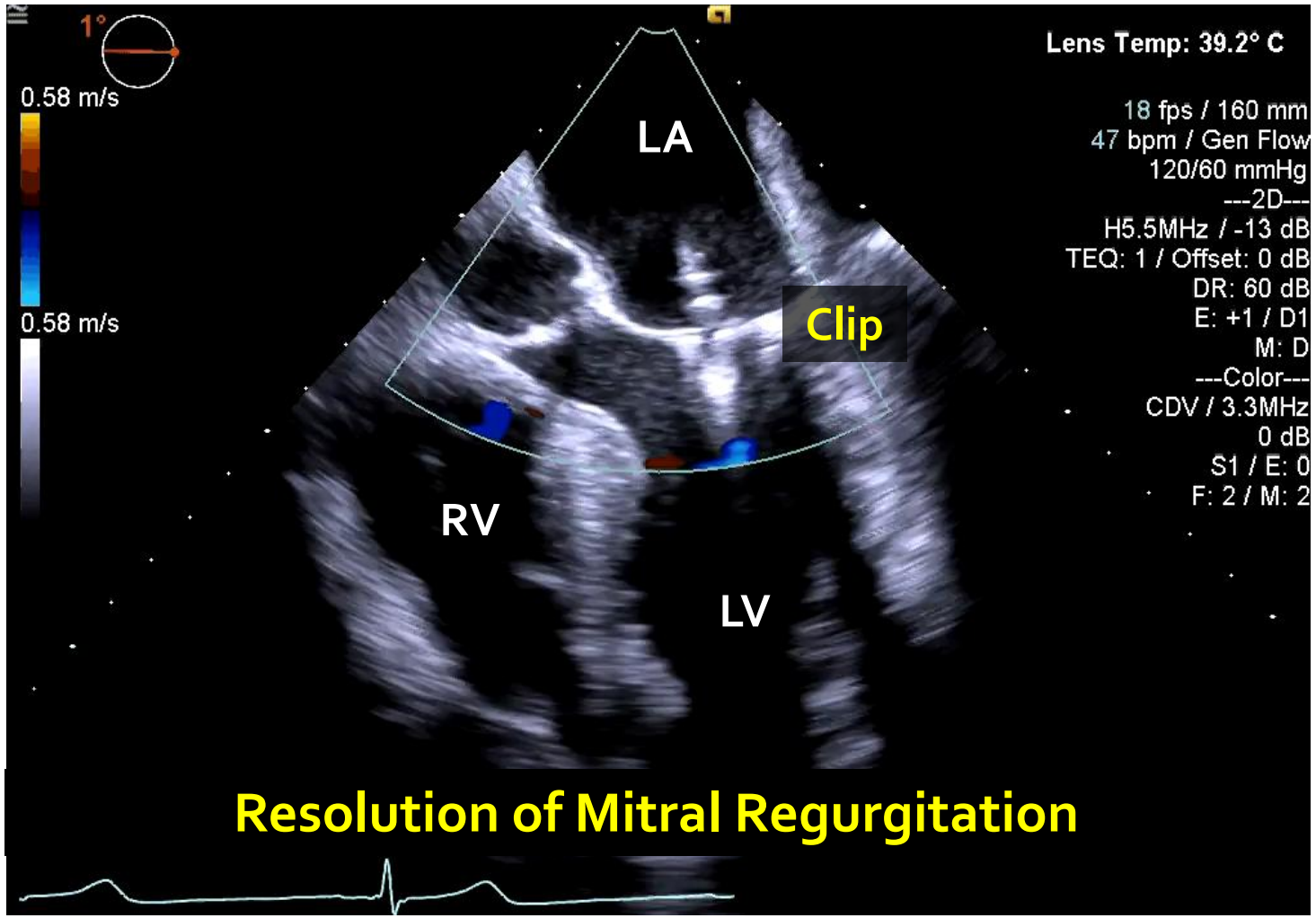
Clip Guidance: Clip Arms Open in LA

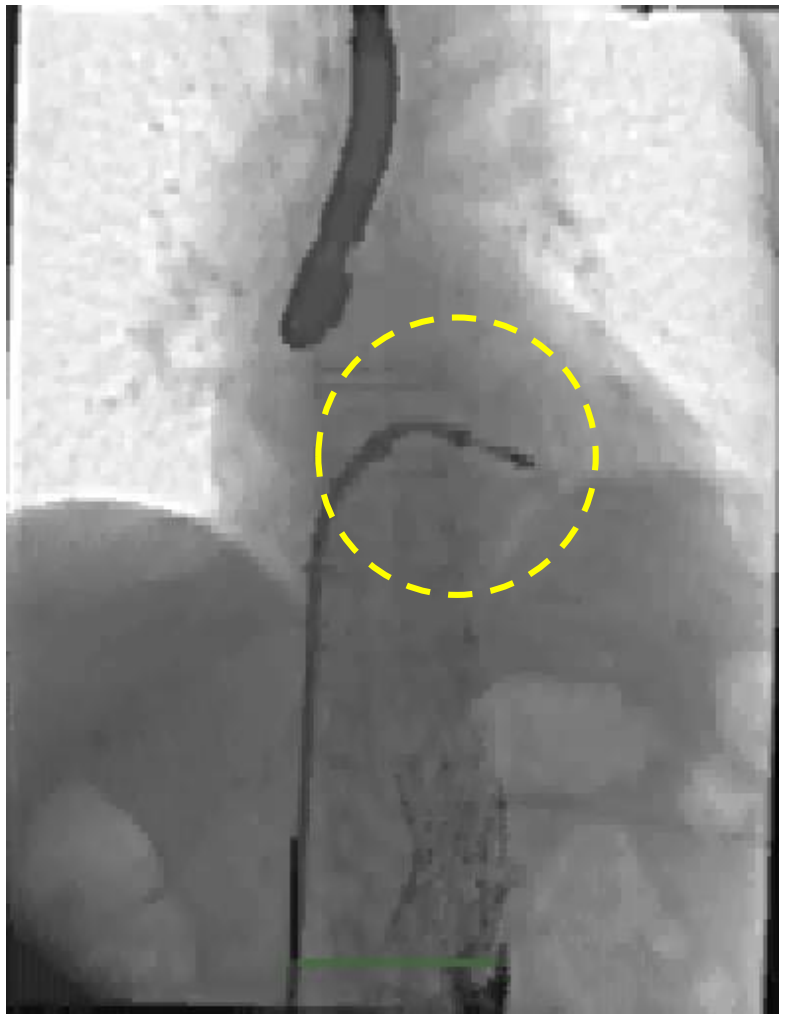


Clip Guidance: Grasping Leaflets in LV

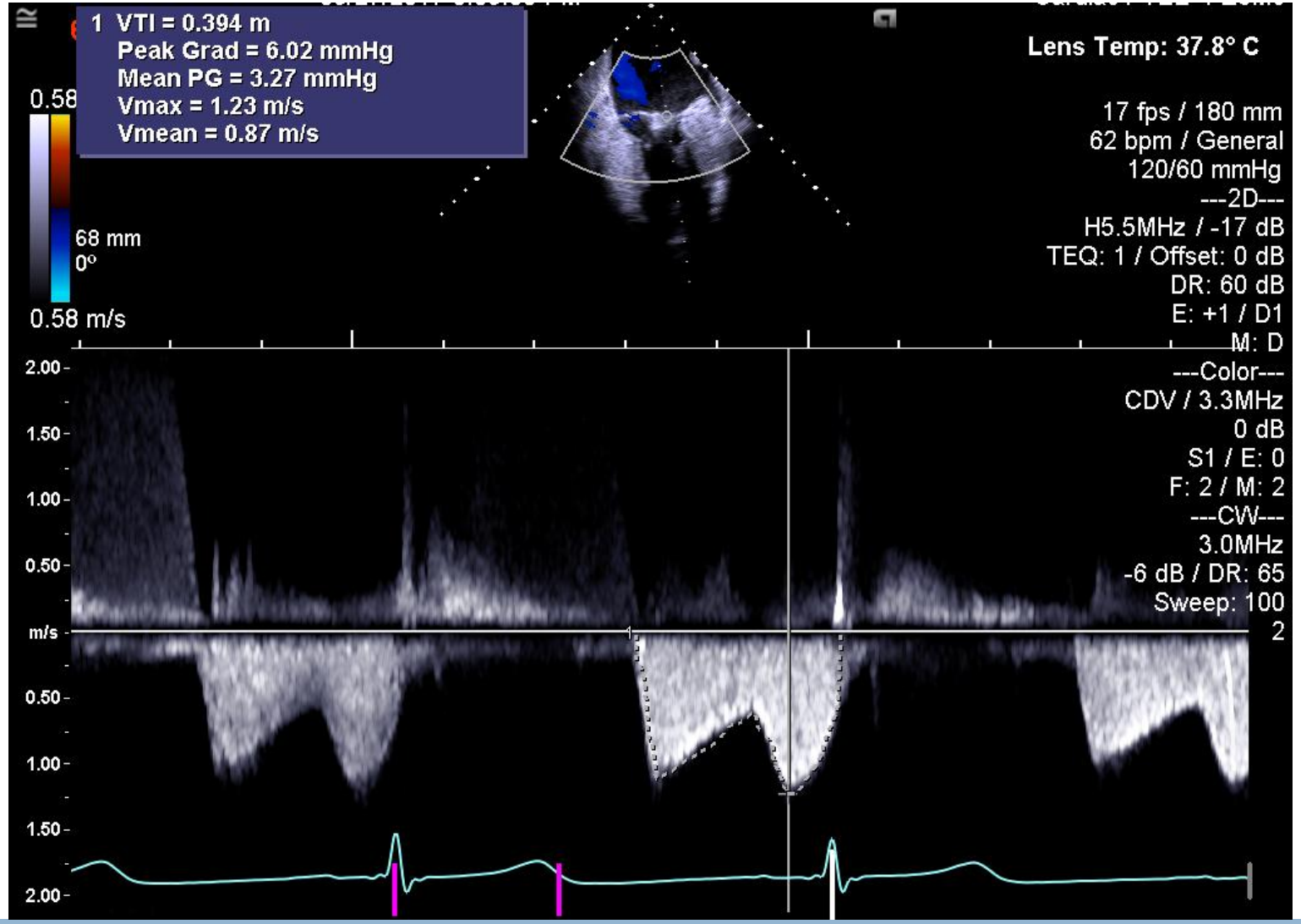


Clip Guidance: Leaflets Grasped



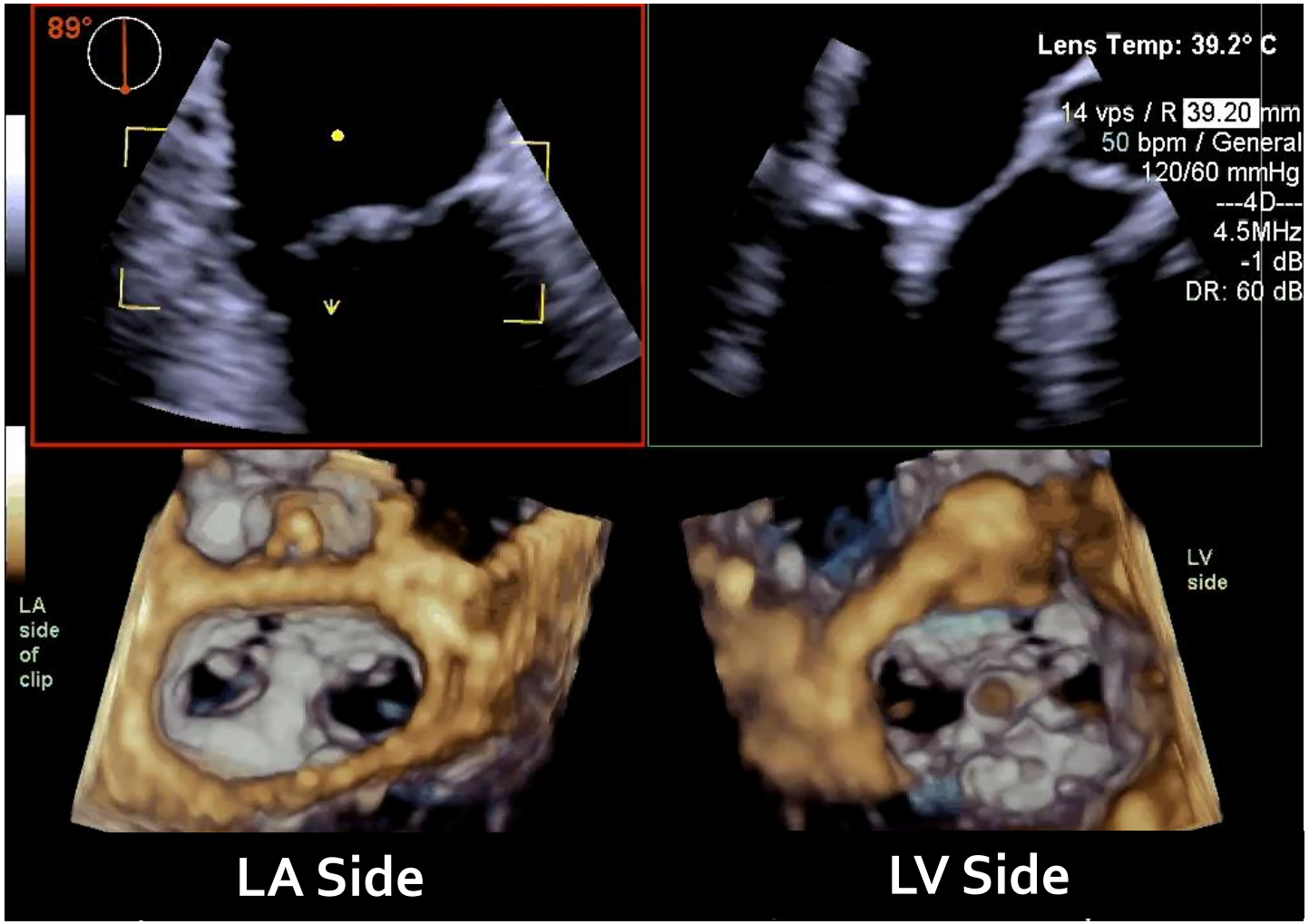


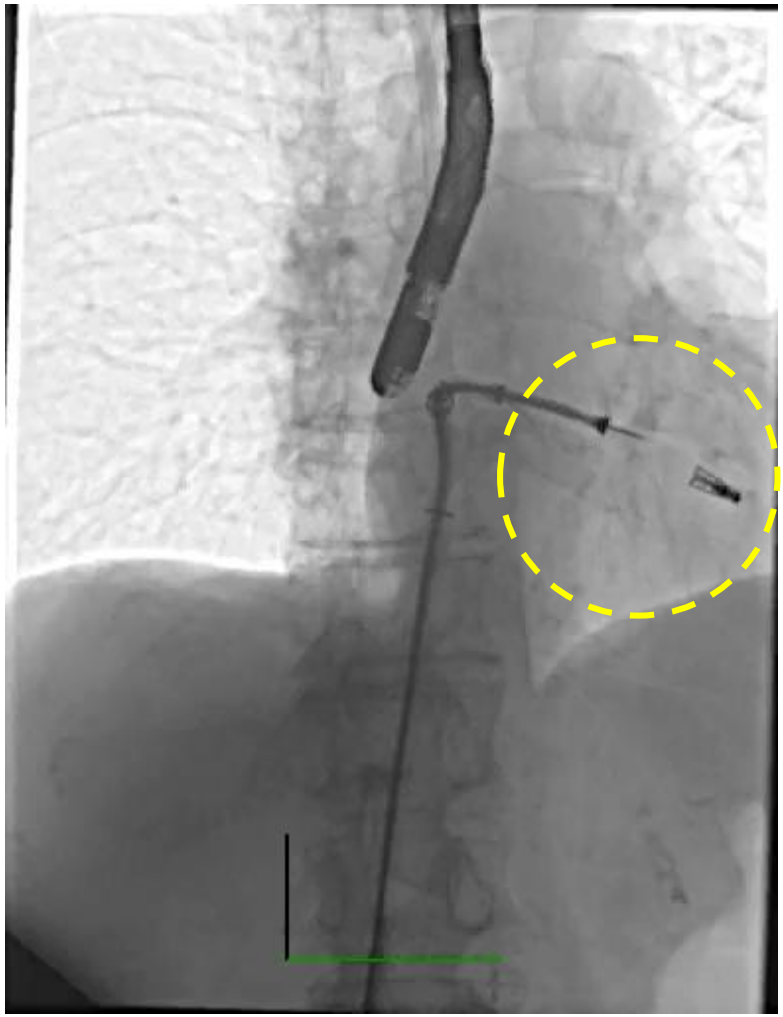
Clip Guidance: Leaflets Grasped



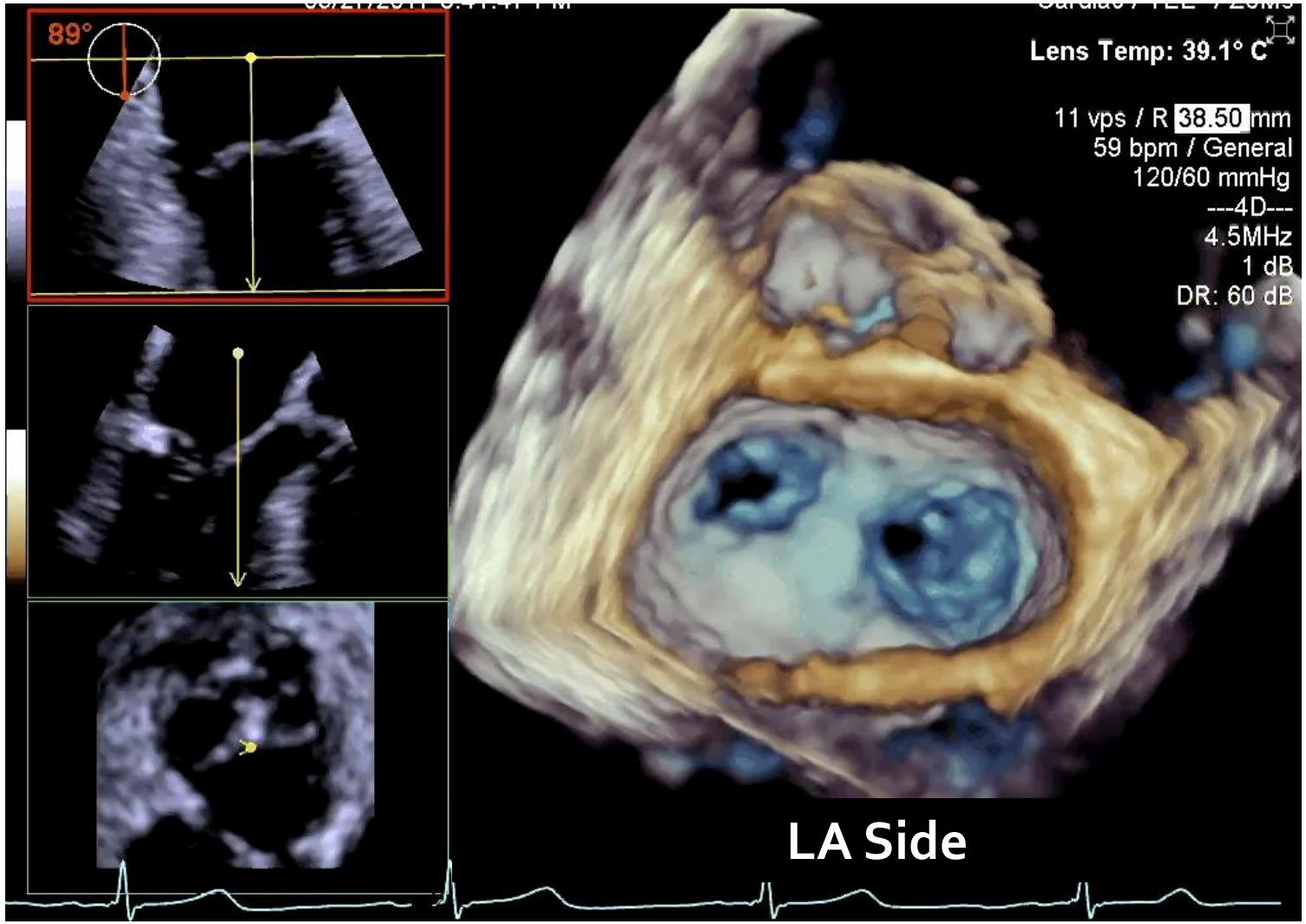
No clip-induced mitral stenosis (mean gradient 3 mm Hg)

Clip Guidance: Clip Released

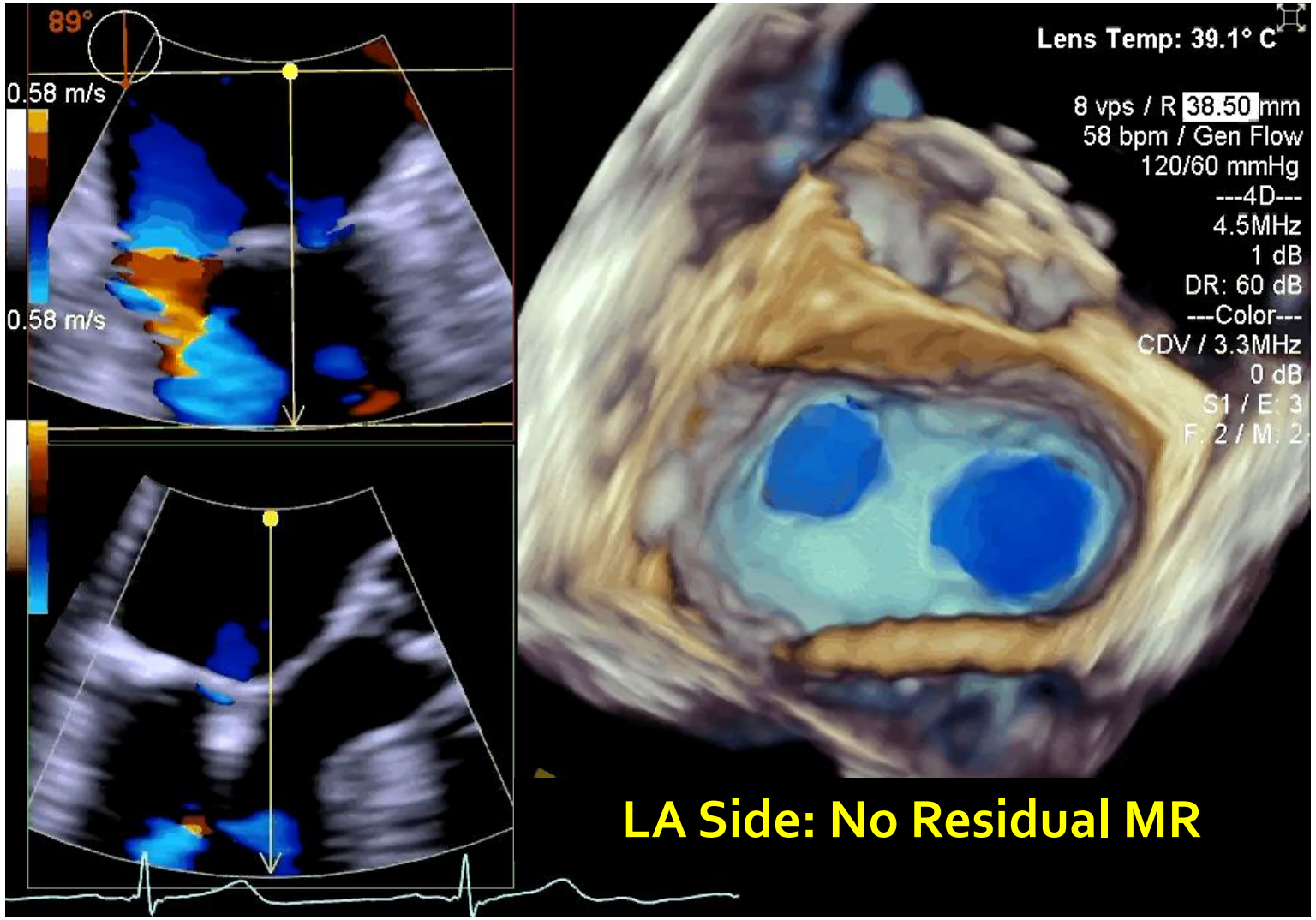




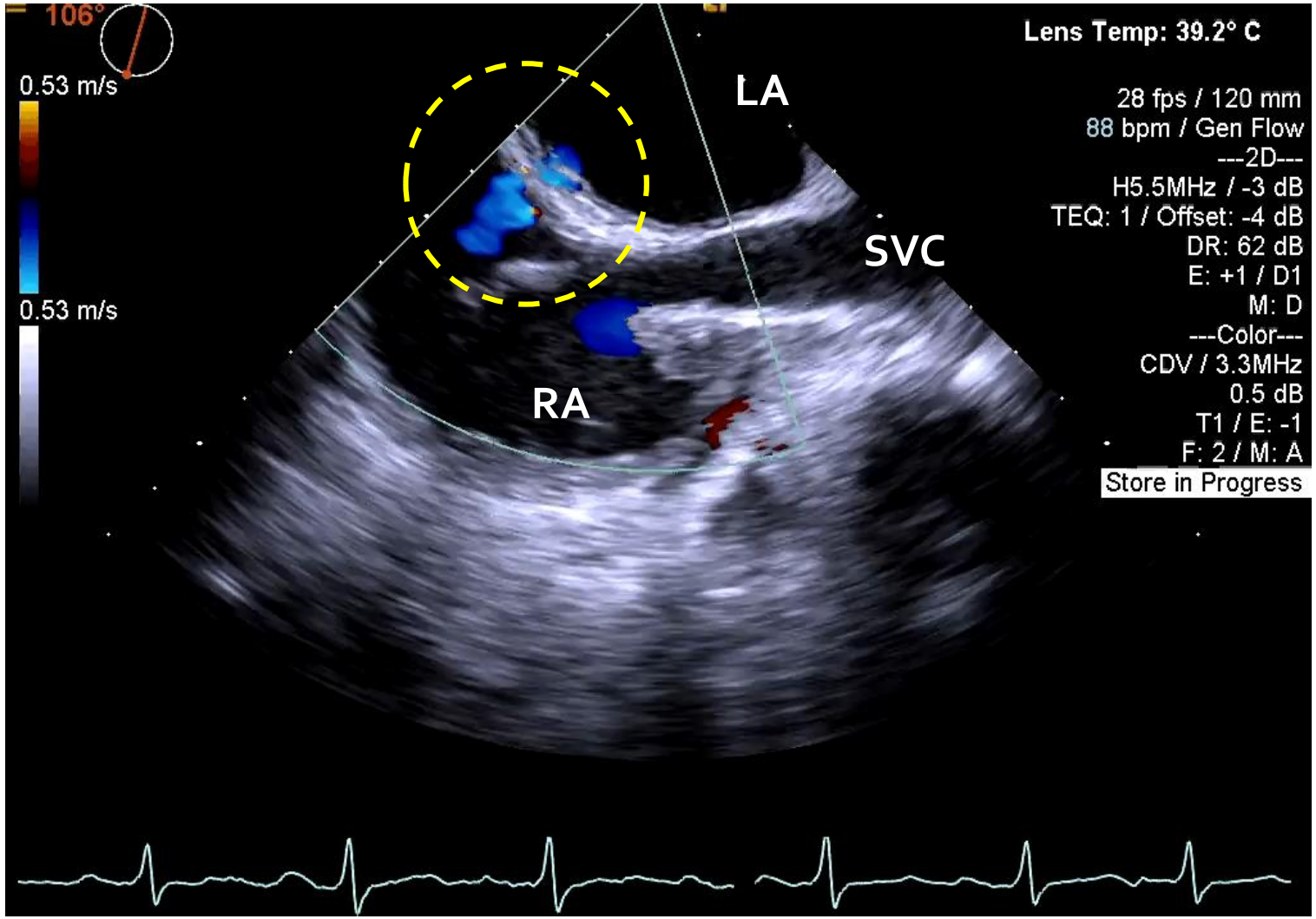
Clip Guidance: Clip Released



Clip Guidance: Clip Released

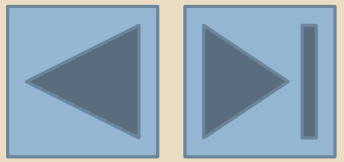


Post Clip: Small Iatrogenic ASD



Typically, ASD at the site of transseptal puncture is small and left alone.

Clip TEE Guidance: Functional MR



Case Presentation

59-year-old man with
ischemic cardiomyopathy and **severe mitral regurgitation**
admitted for yet another episode of congestive heart failure exacerbation
despite optimal medical therapy at home

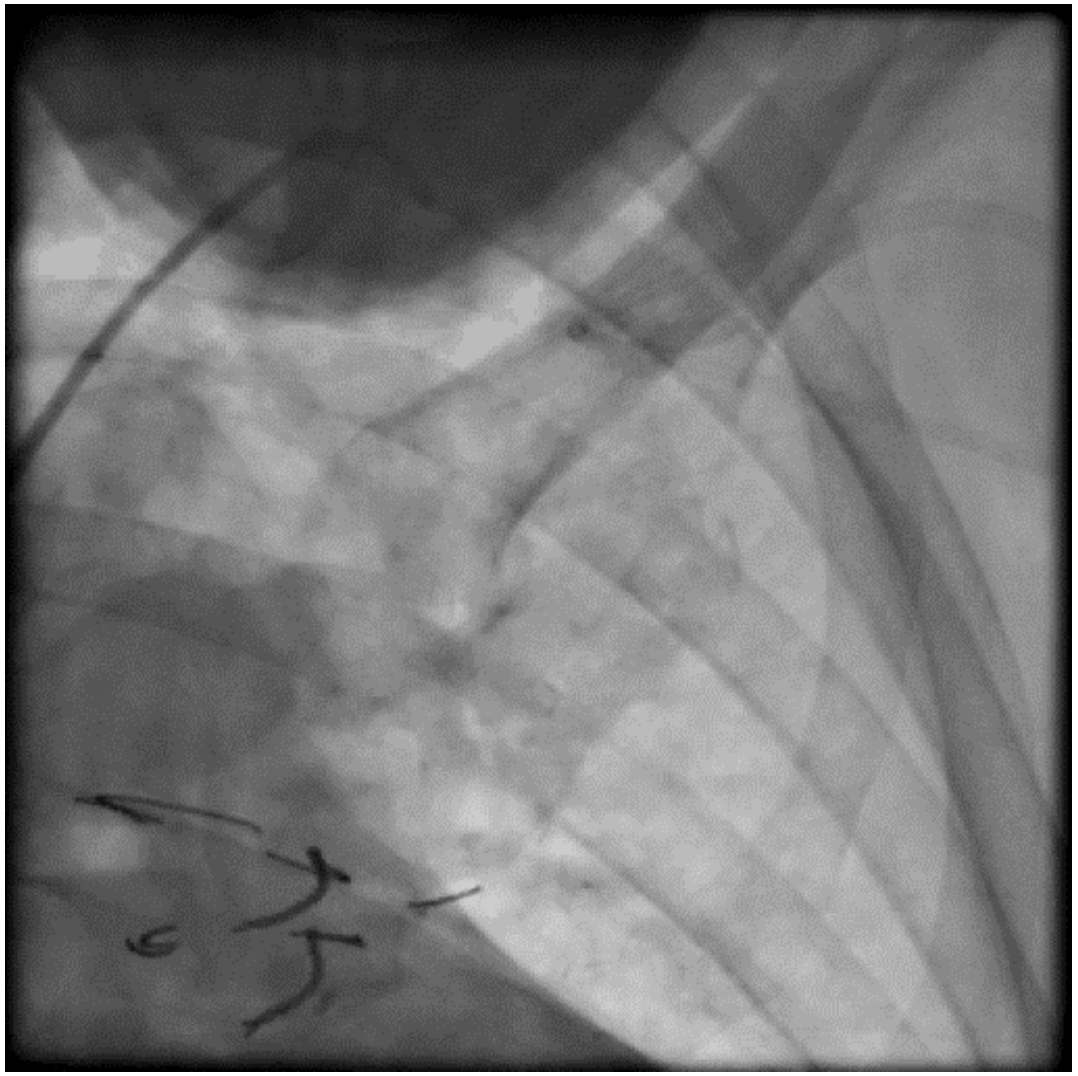
Past Medical History

- Myocardial infection at age 48 years
- Hypertension
- AIDS

Past Surgical History

- CABG at age 49 years

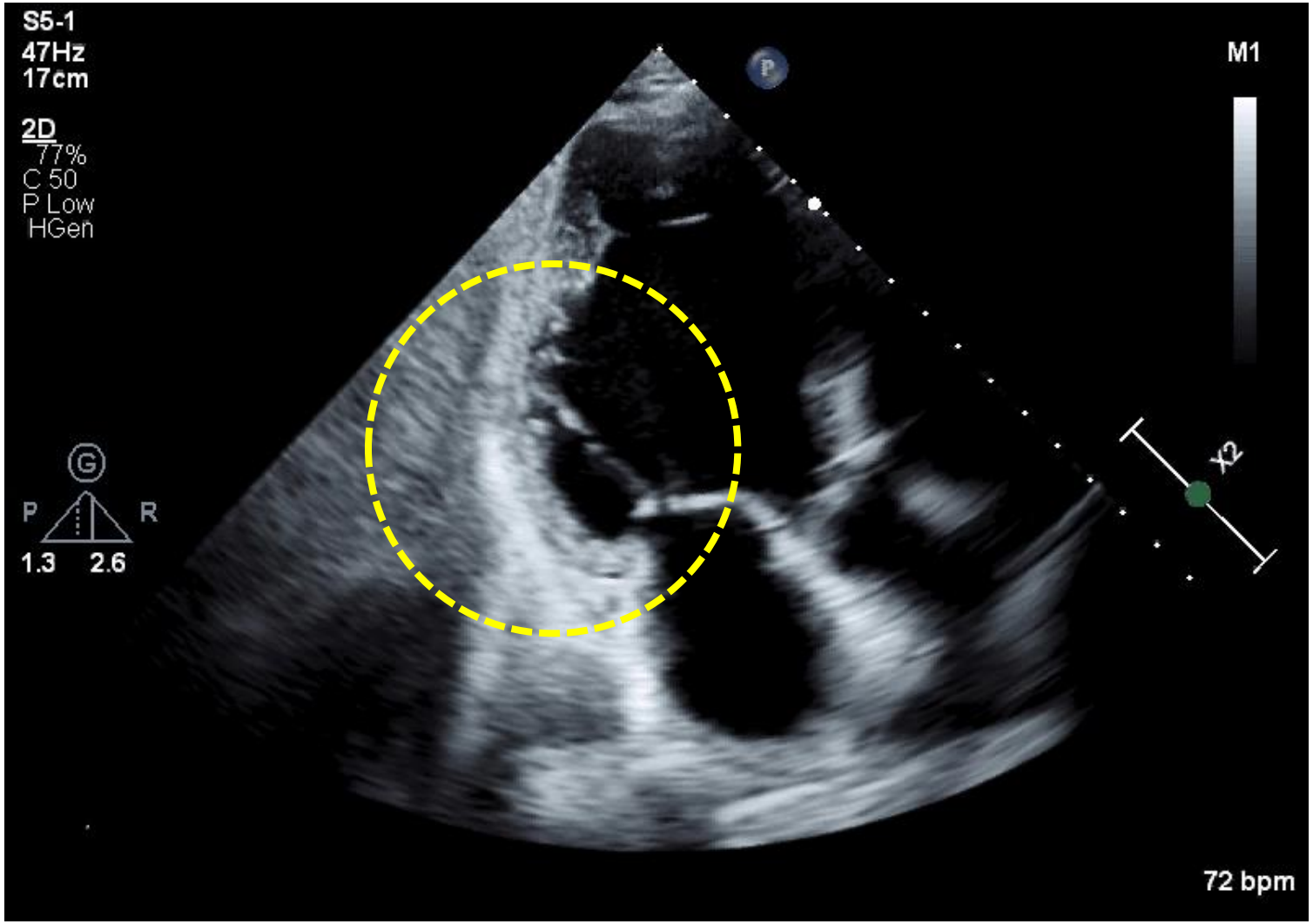
Coronary Angiography



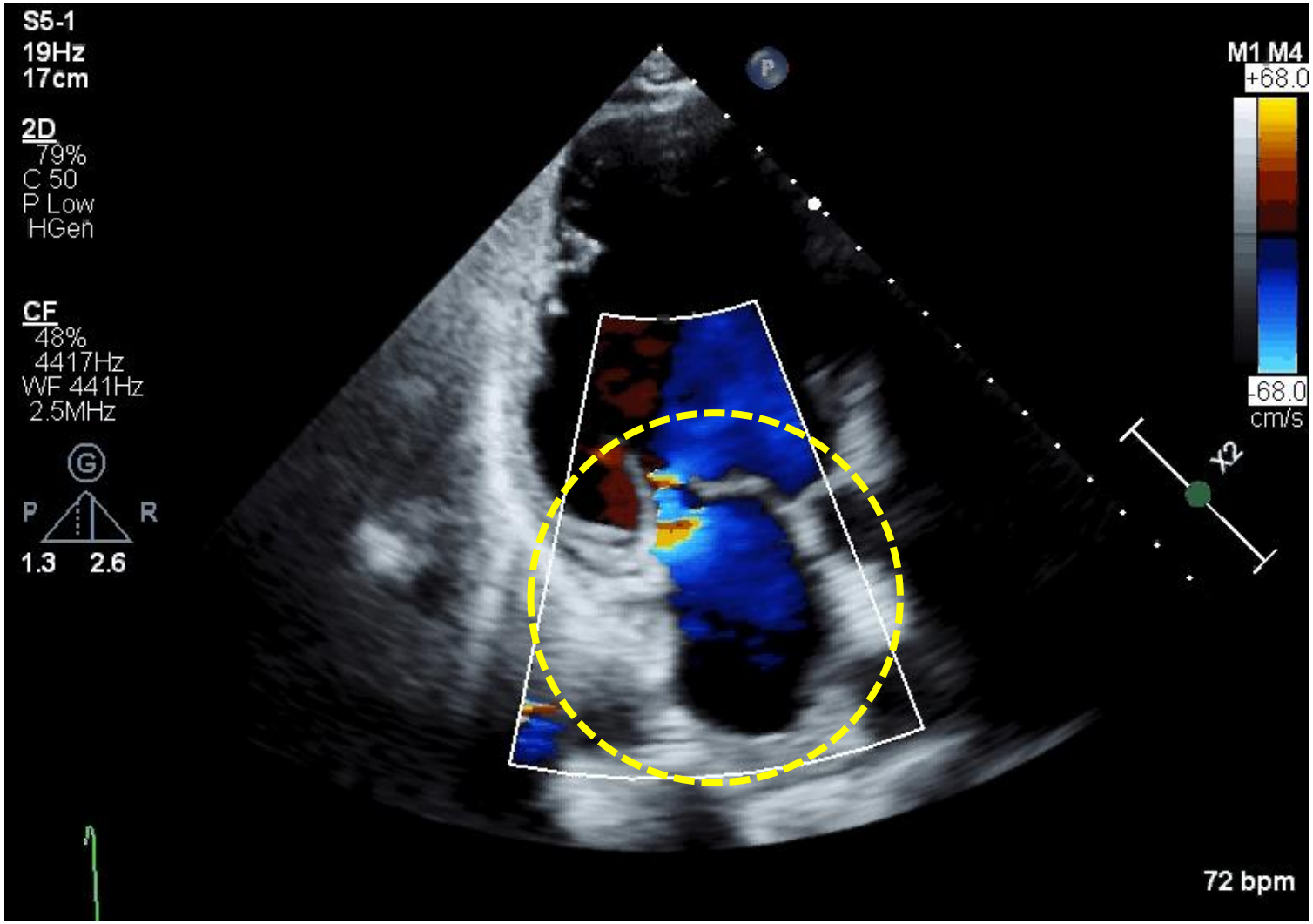
- Extensive native CAD
- LIMA to LAD is the only patent graft

- No further percutaneous revascularization deemed feasible

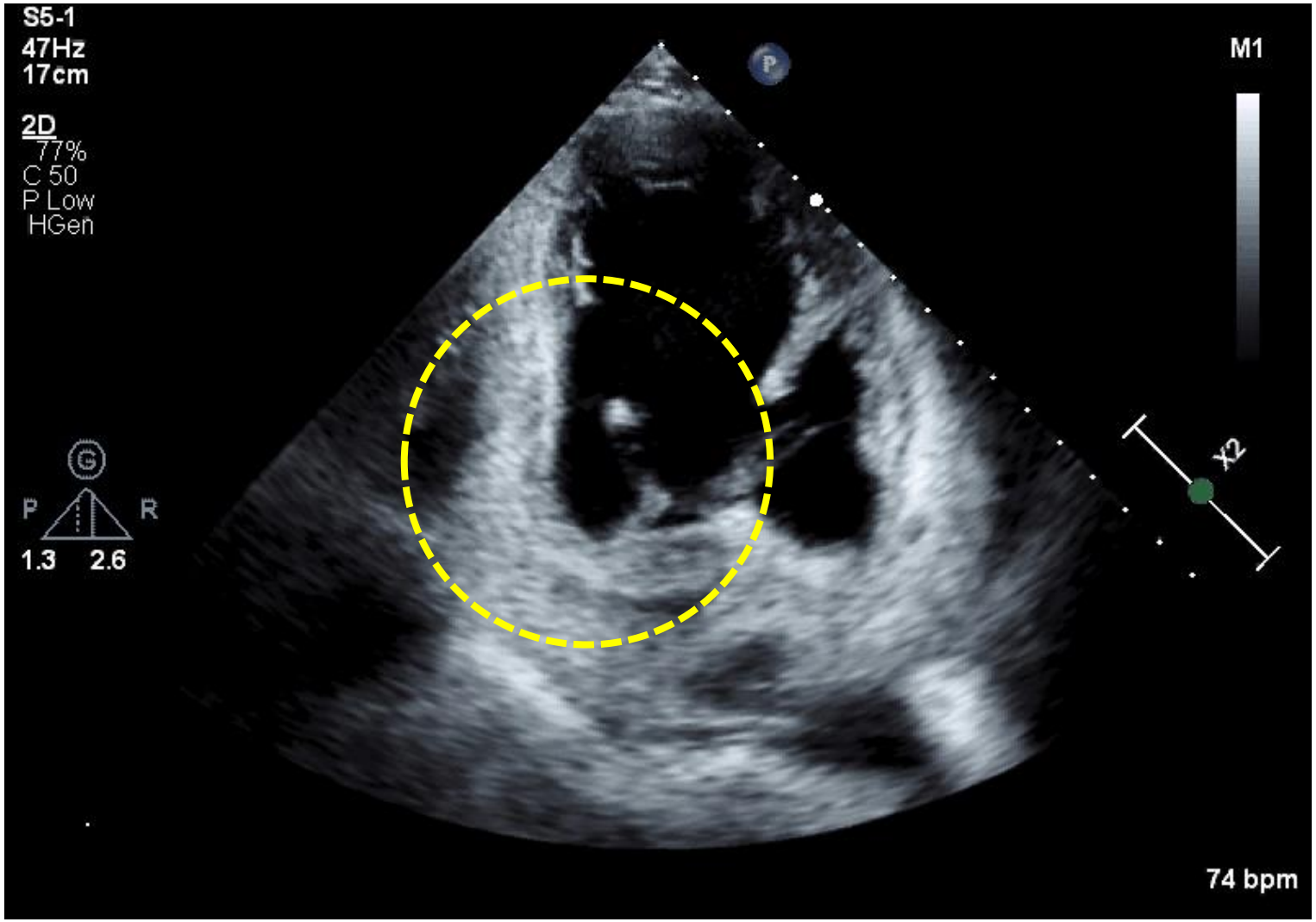
TTE: Apical 3-Chamber View



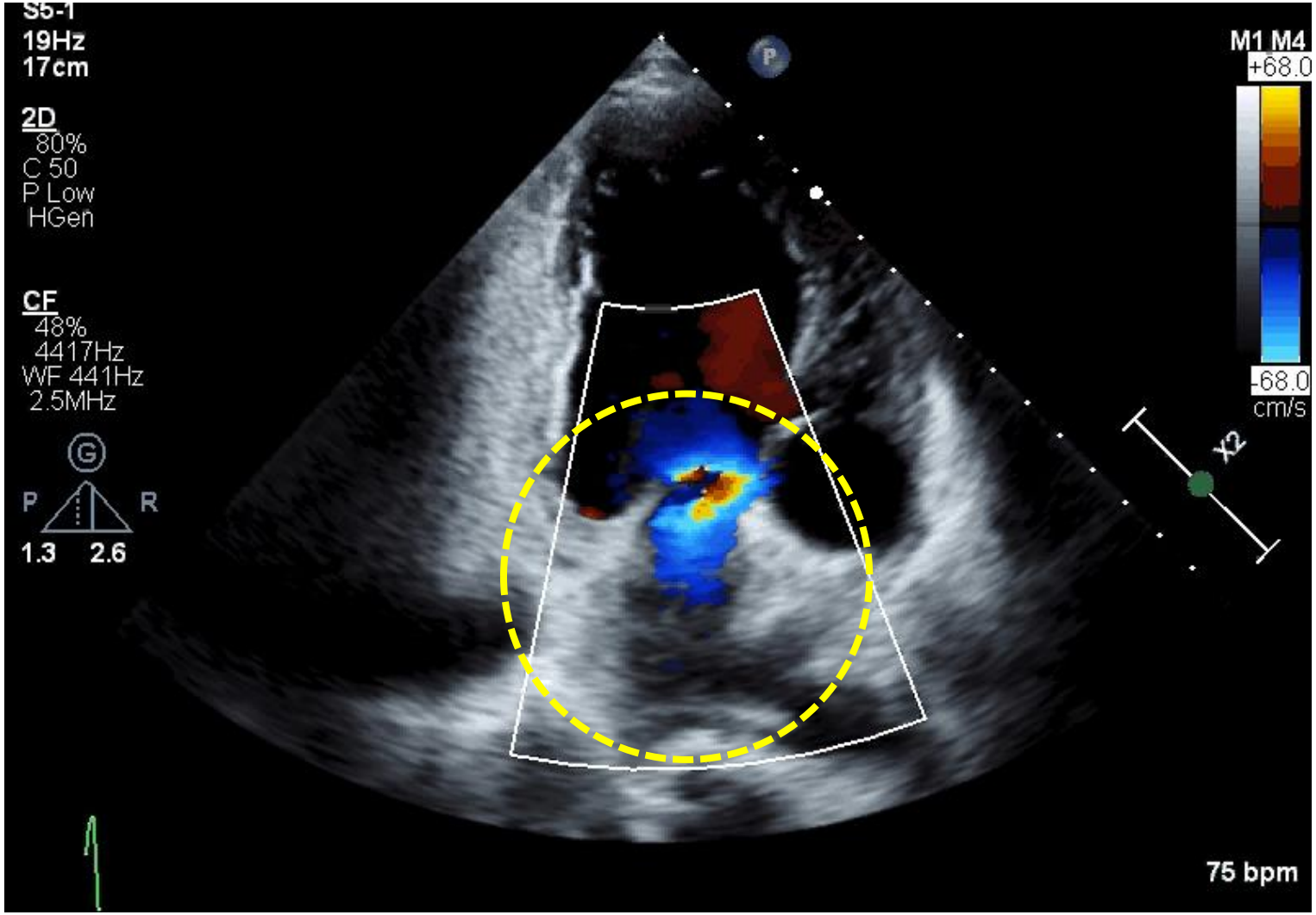
TTE: Apical 3-Chamber View



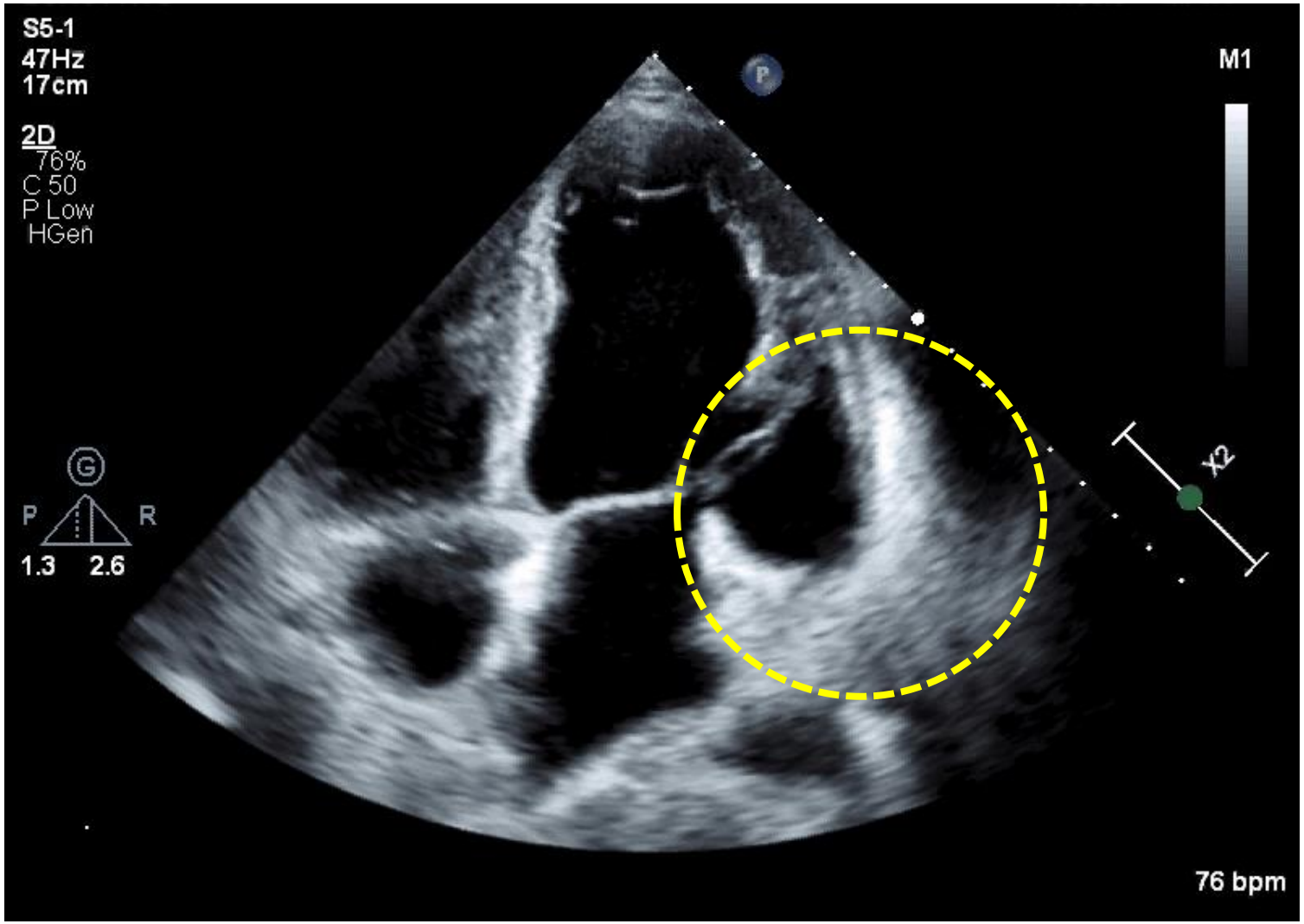
TTE: Apical 2-Chamber View



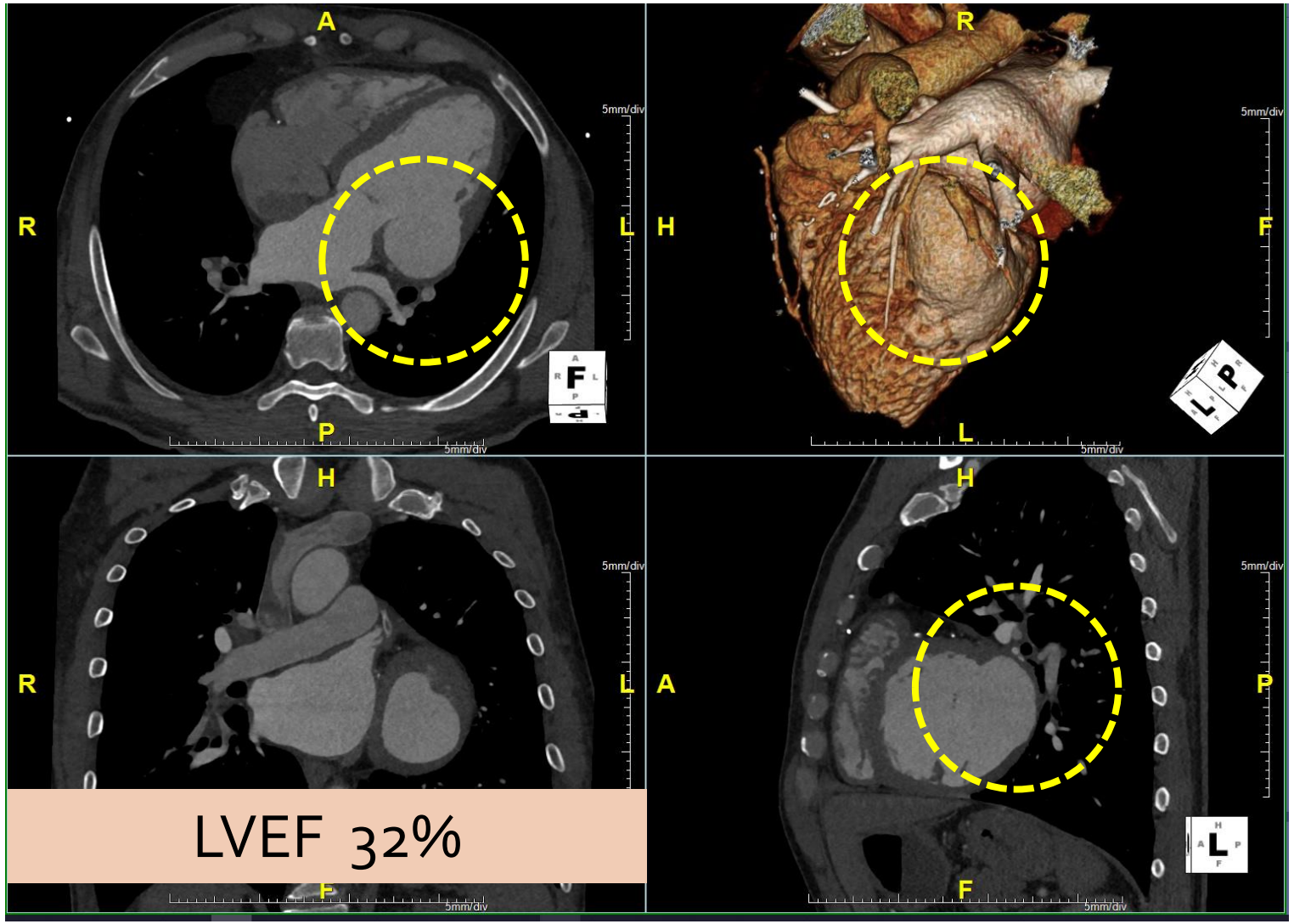
TTE: Apical 2-Chamber View



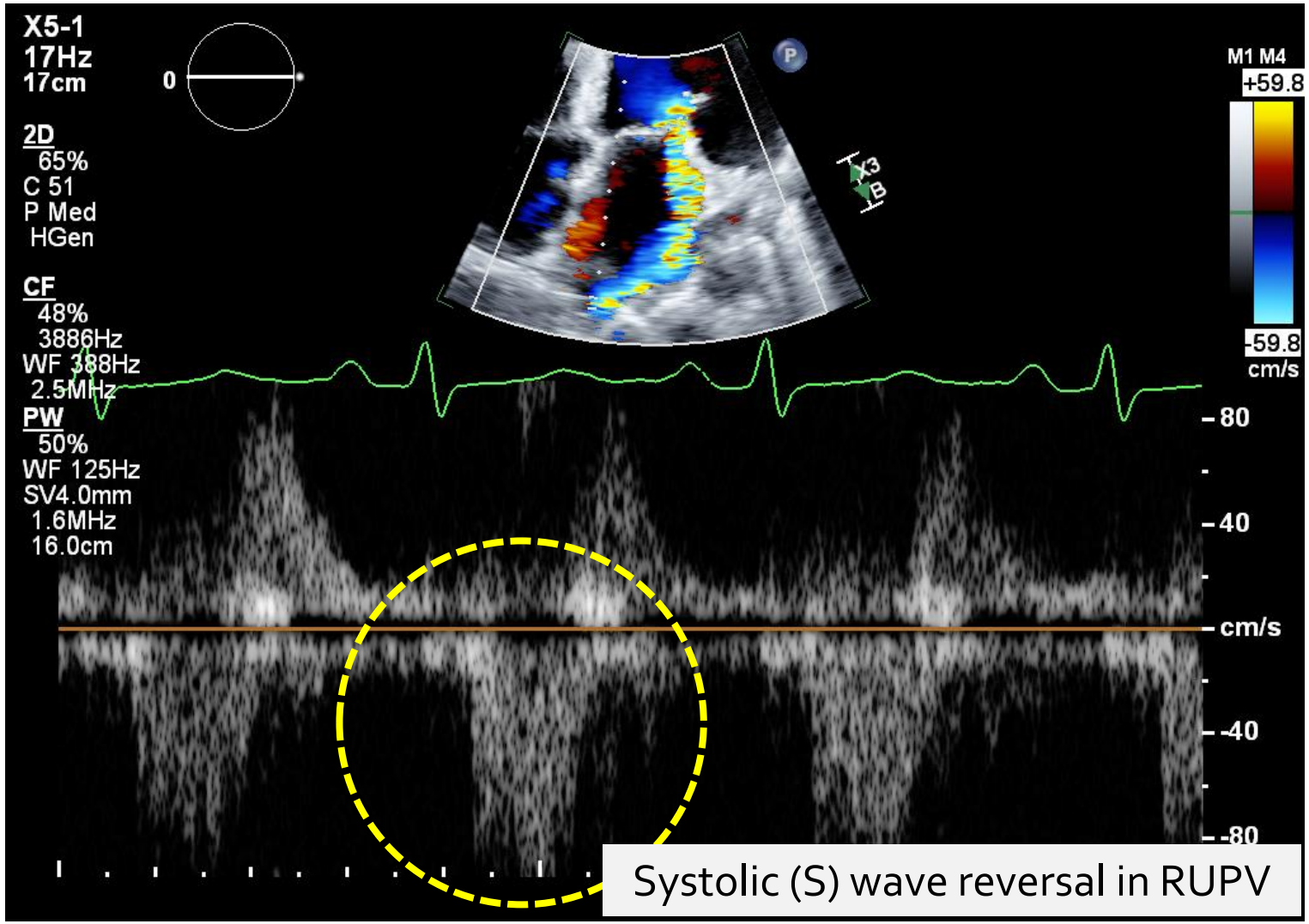
TTE: Apical 4-Chamber View



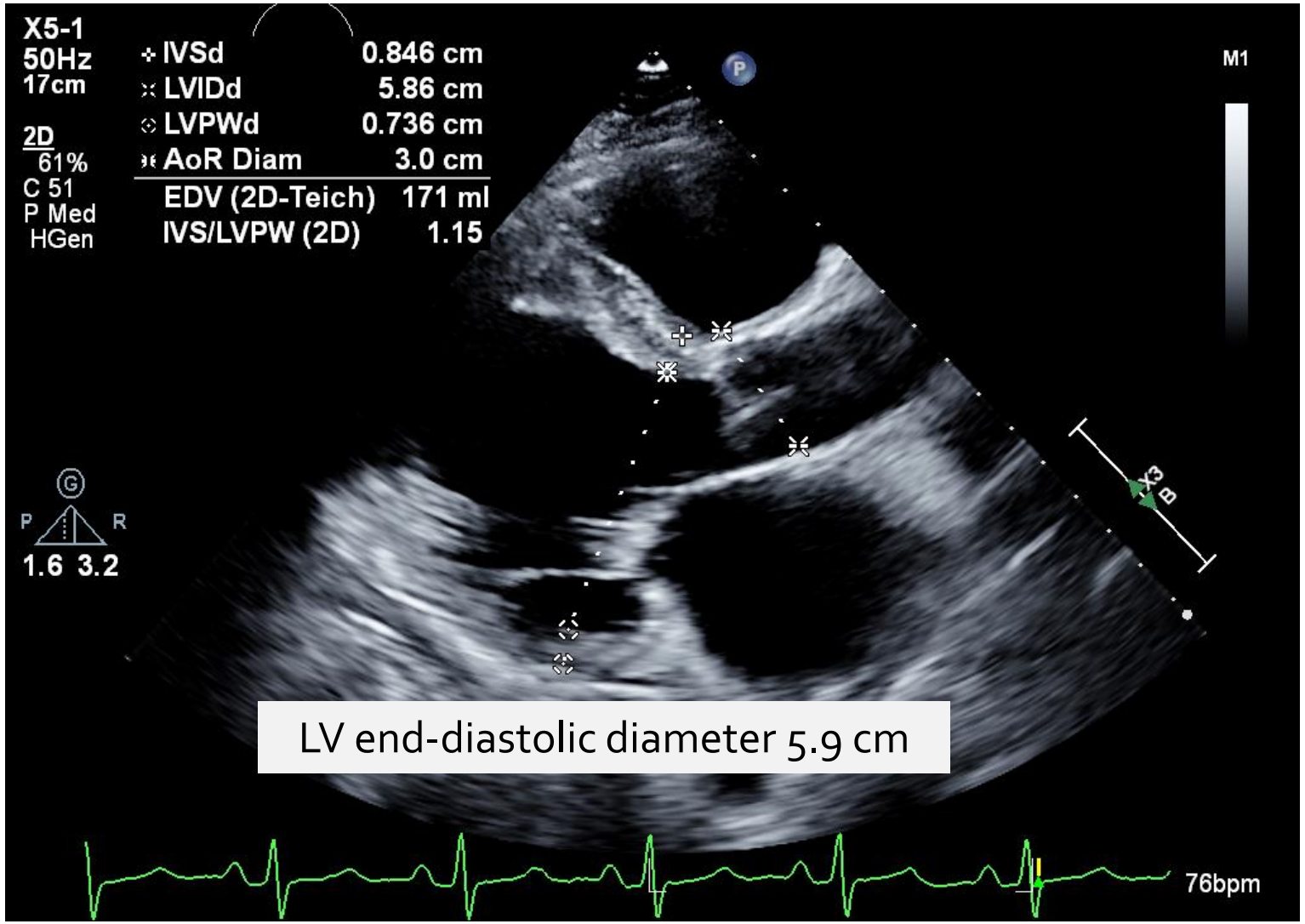
EKG-gated Cardiac 3D-CT



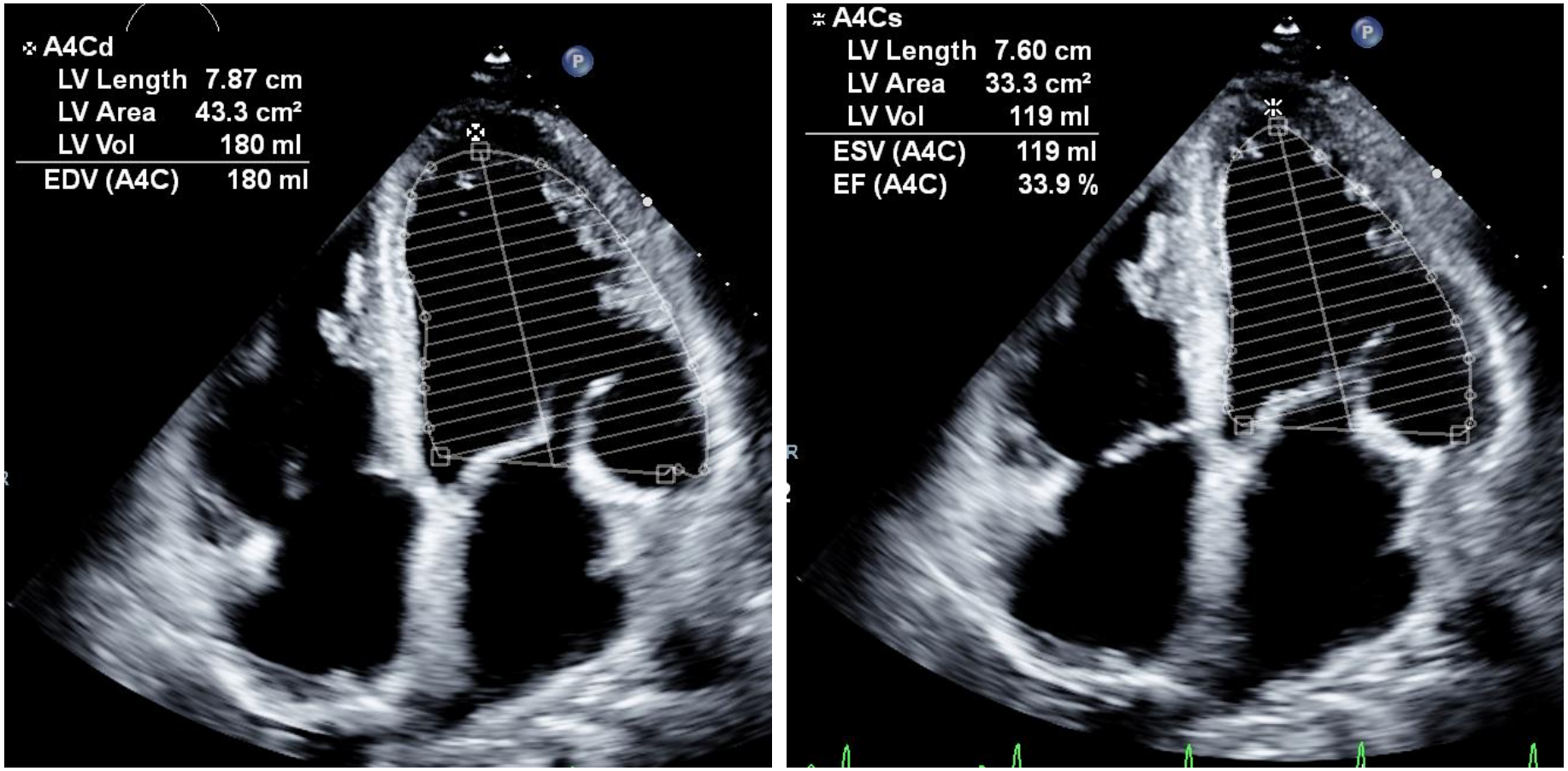
TTE: Apical 4-Chamber View



TTE: Parasternal Long-Axis View



TTE: Apical Views

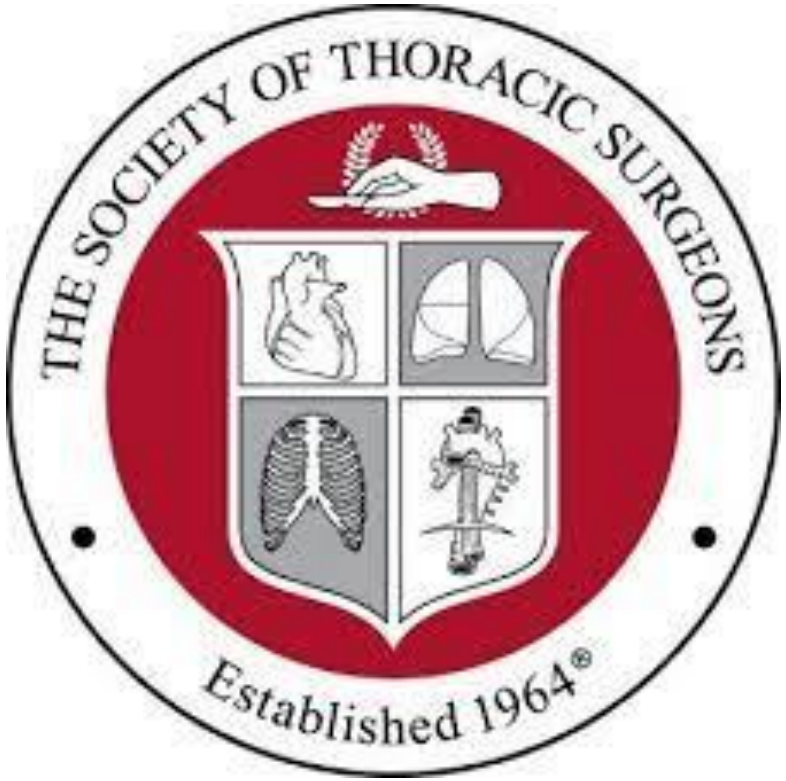


LVEF by Biplane Simpson's ~**35%**

TTE Conclusion

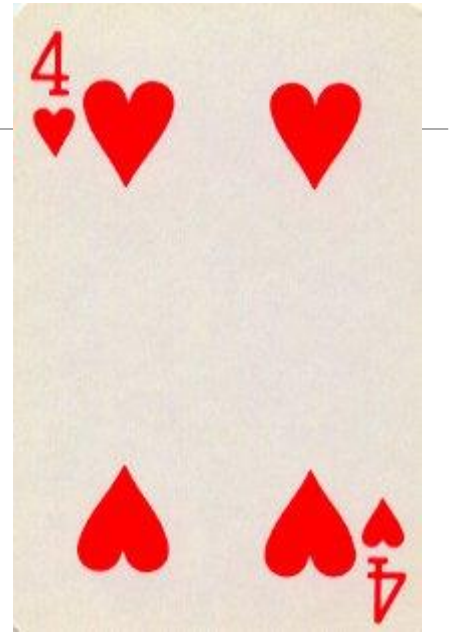
- Severe functional ischemic mitral regurgitation
- LVEF ~ 35%
- LV end-diastolic diameter 5.9 cm

What is His Risk of Surgical Repair?



Procedure: Isolated MVR
Risk of Mortality:
4.983%
Renal Failure:
4.540%
Permanent Stroke:
1.628%
Prolonged Ventilation:
20.893%
DSW Infection:
0.663%
Reoperation:
4.024%
Morbidity or Mortality:
28.276%

Pre-Clip Echo Evaluation



4 Questions to Answer

- **Q1 : Mitral regurgitation type**
  - Is mitral regurgitation degenerative or functional?
- **Q2: Severity of mitral regurgitation**
  - Is mitral regurgitation at least moderate to severe (3+ or 4+)?
- **Q3: Mitral valve anatomy**
  - Is mitral valve anatomy suitable for clipping?
- **Q4: Contraindication**
  - Are there any general procedural contraindication for this left heart procedure?

MitraClip: FDA Requirements

Functional MR: MitraClip Requirements

- ✓ Severe MR
- ✓ 20% ≤ LVEF ≤ 50%
- ✓ LV end-systolic diameter ≤ 7.0 cm
- ✓ Symptomatic despite optimal medical therapy

MitraClip: Anatomic Requirements

Preprocedural TEE

✓

MR JET ORIGIN

- The primary regurgitant jet is non-commissural
- If a secondary jet exists, it must be considered clinically insignificant

MV AREA

- Mitral valve area ≥ 4.0cm²

GRASPING AREA

- Minimal calcification
- No cleft in the grasping area

Preprocedural TEE

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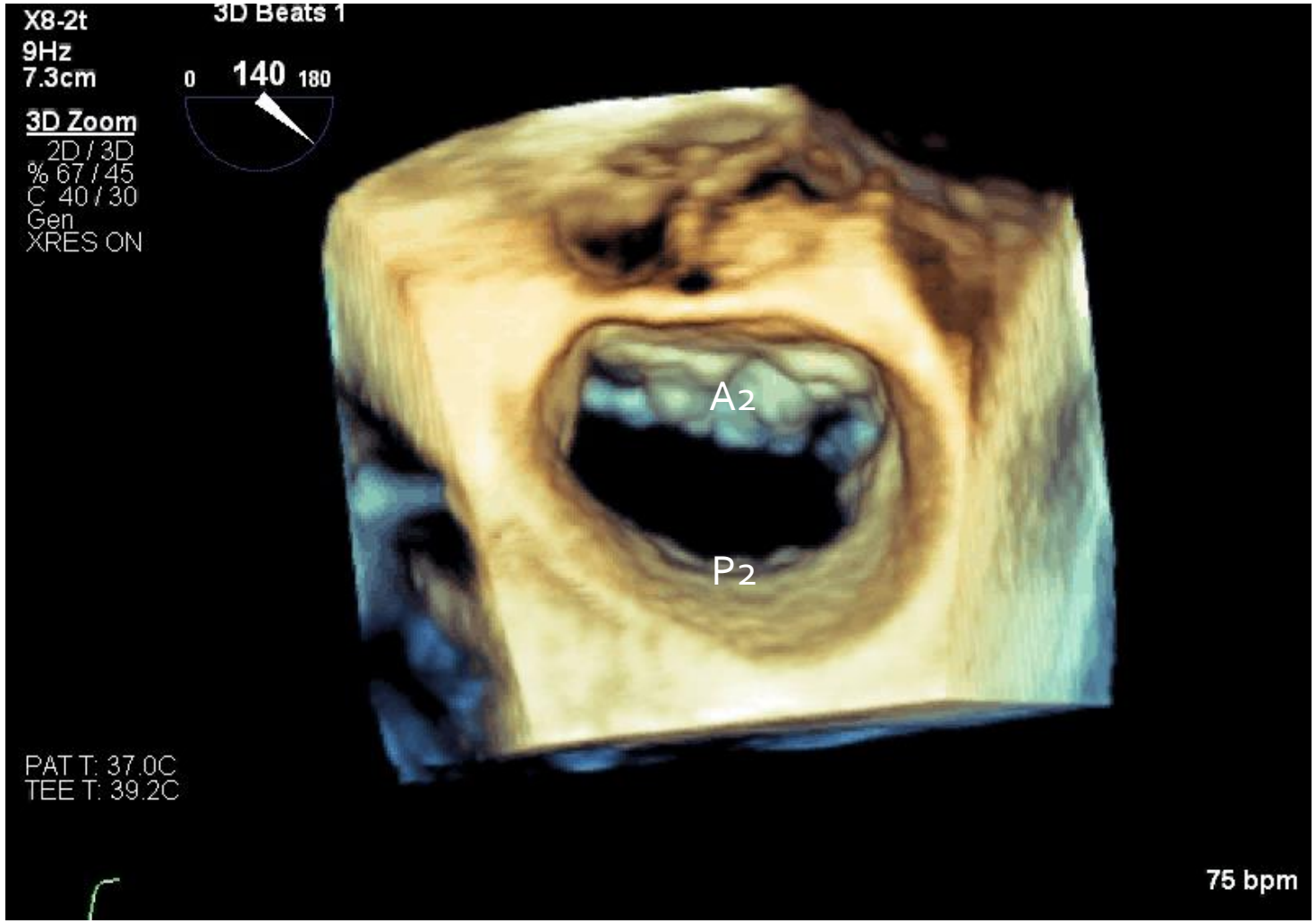

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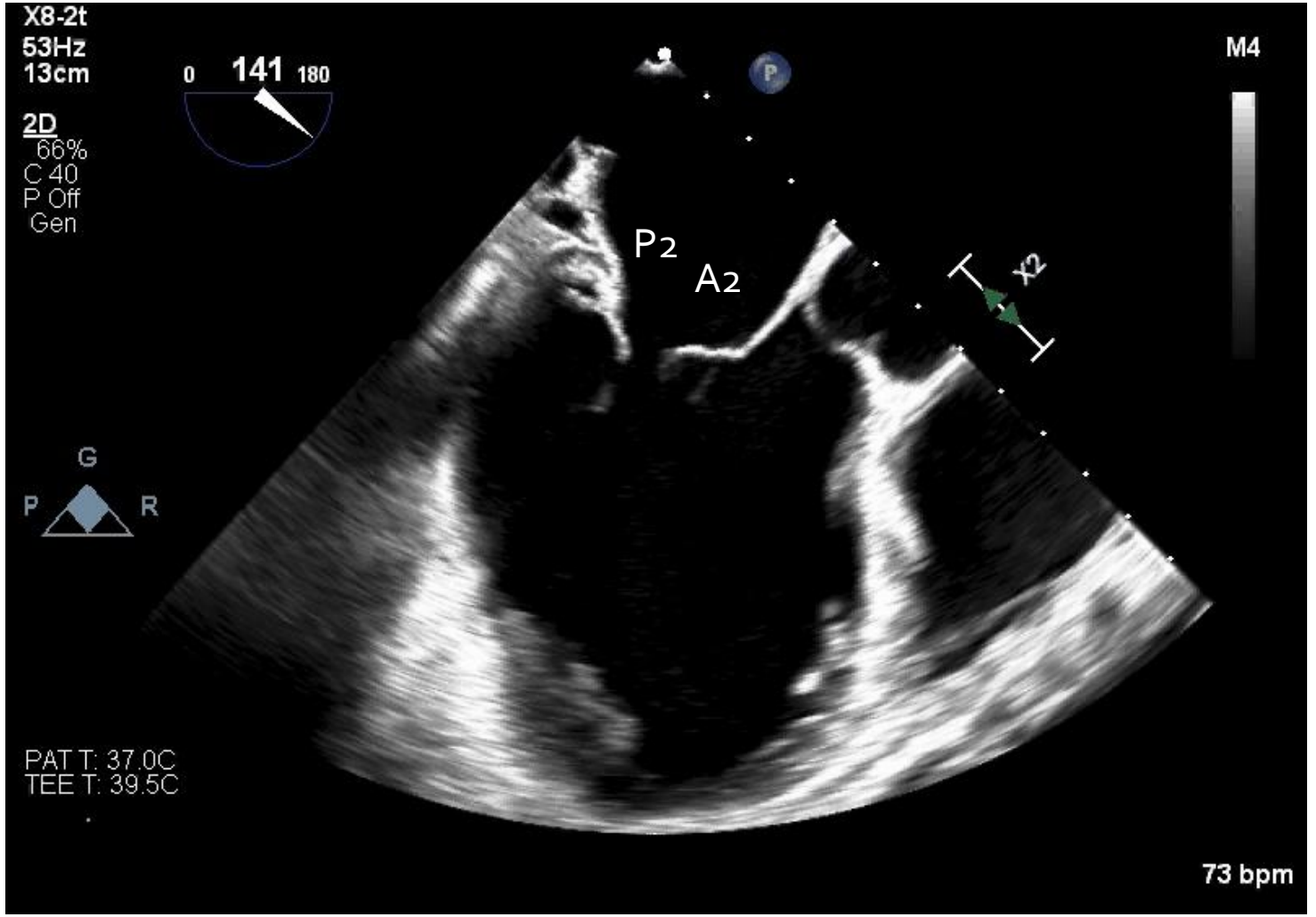

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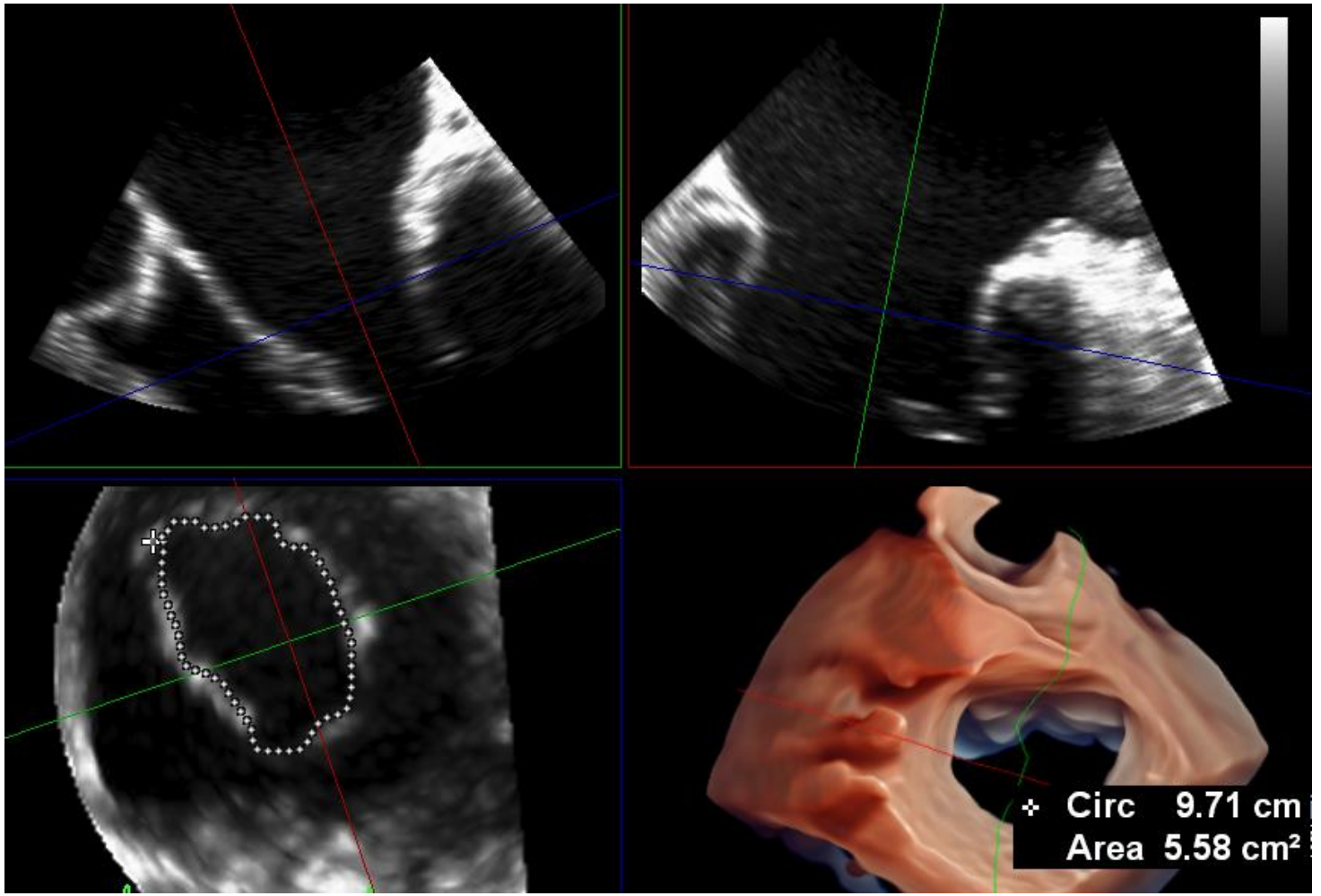


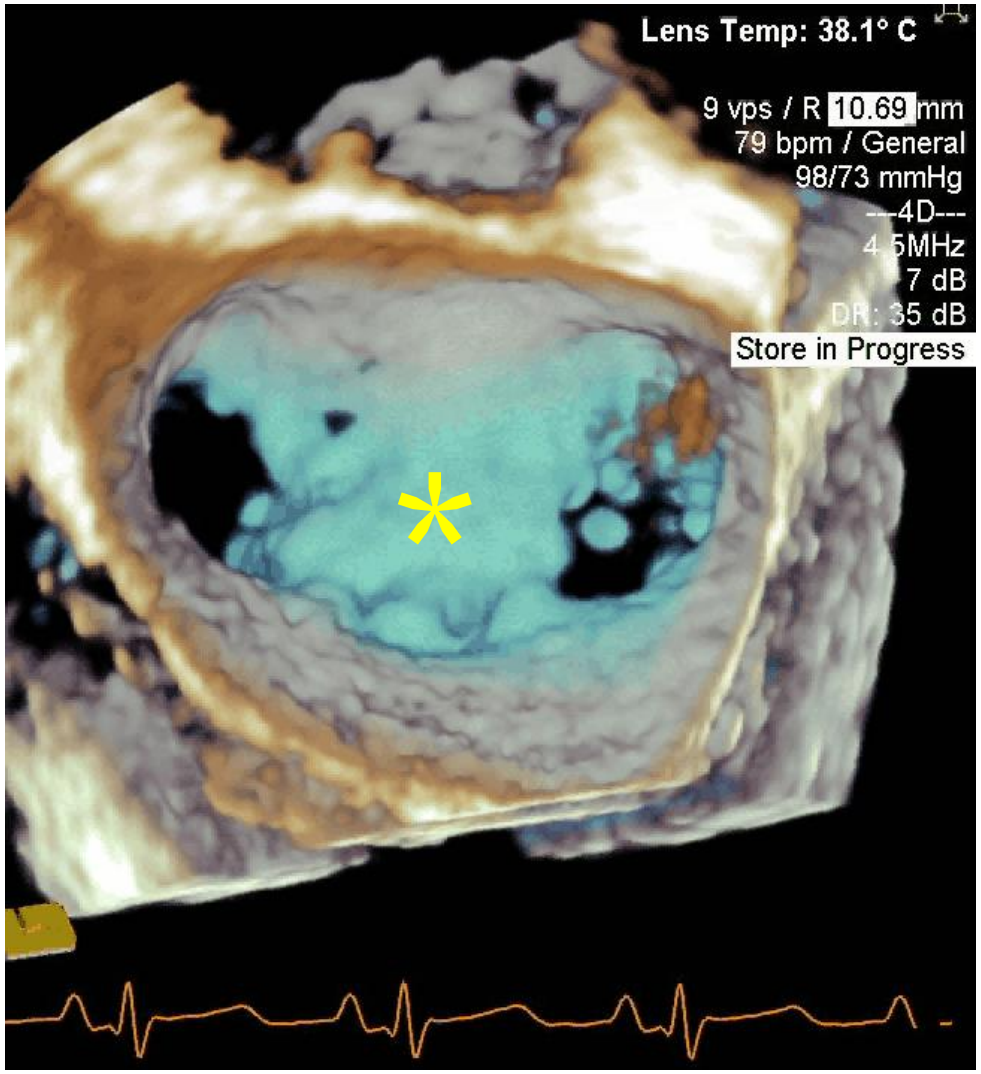
Contraindications for MitraClip

- Active endocarditis of the mitral valve
- Rheumatic mitral valve disease
- Evidence of intracardiac, inferior vena cava (IVC) or femoral venous thrombus
- Intolerance to procedural anticoagulation or post procedural antiplatelet regimen

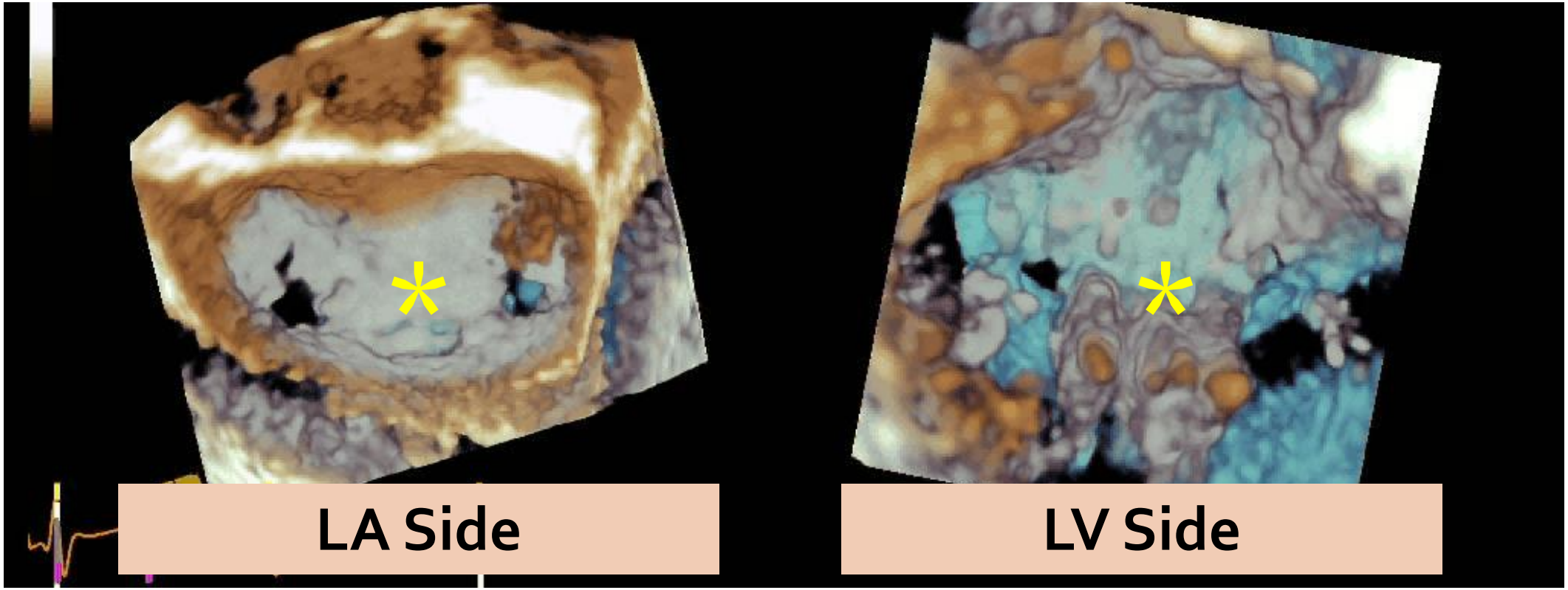
Imaging & Clinical Findings Conclusion

Patient is a candidate for MitraClip procedure to treat severe symptomatic functional ischemic MR

Procedural TEE: 3 Mitral Clips

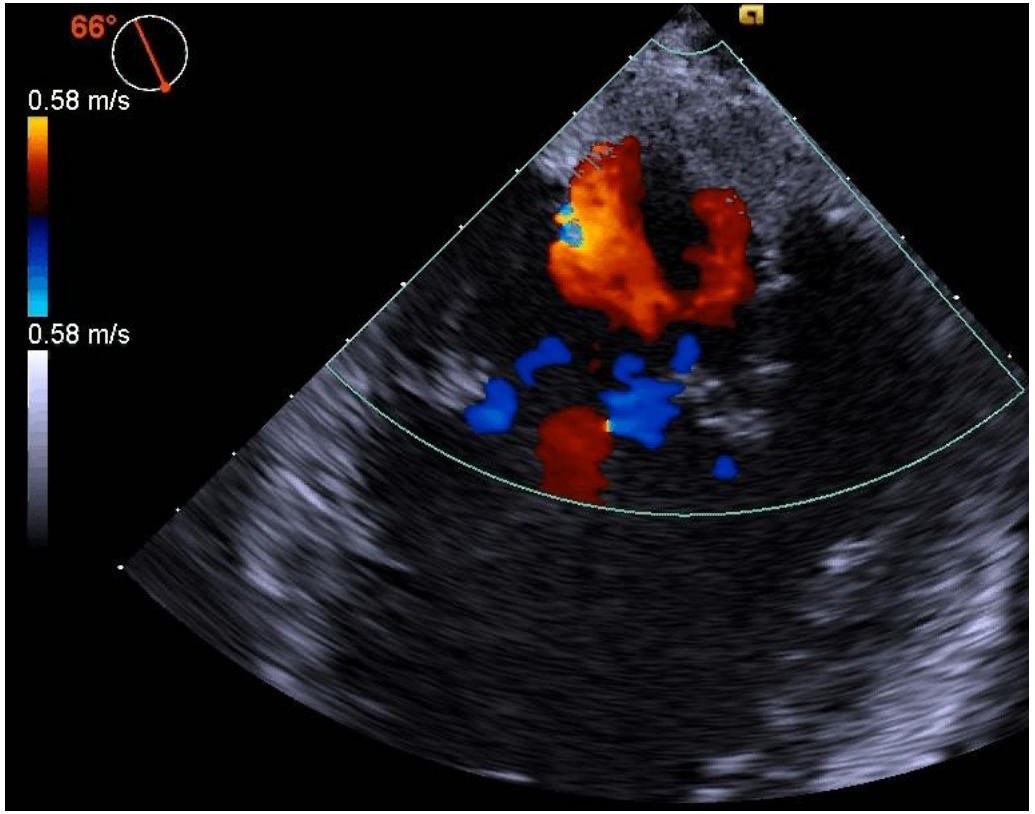


Procedural TEE: 3 Mitral Clips

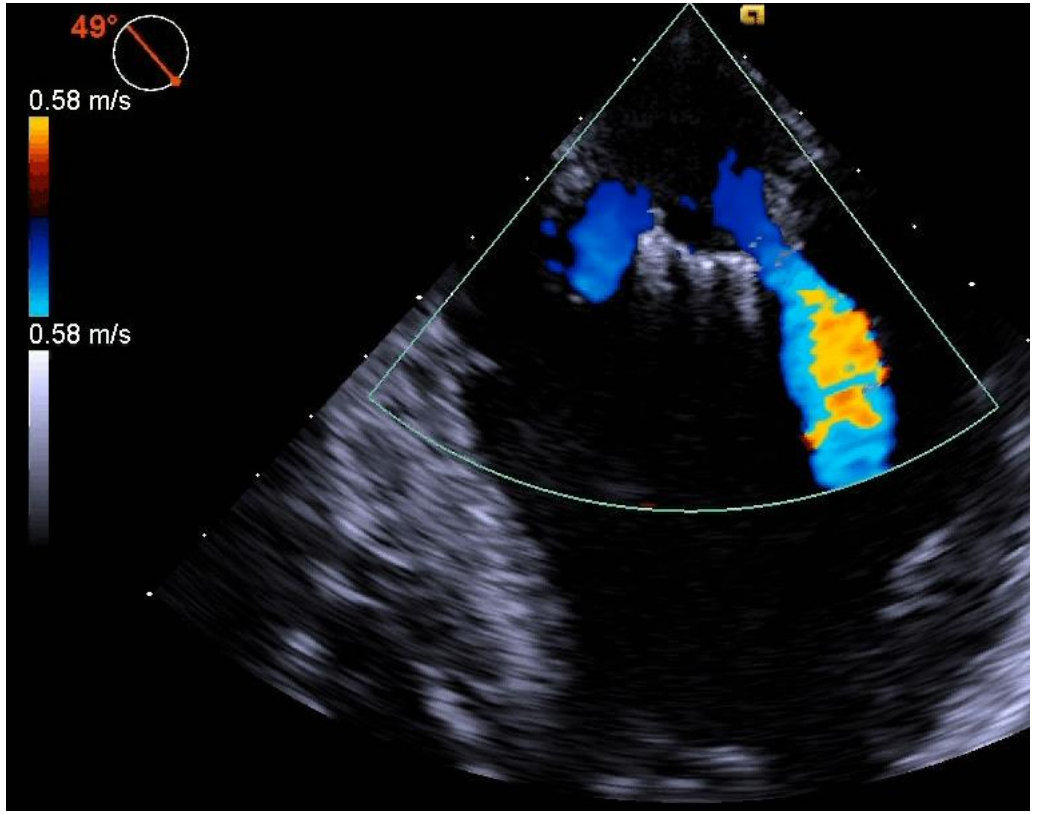


Procedural Success: MR Jet

Baseline

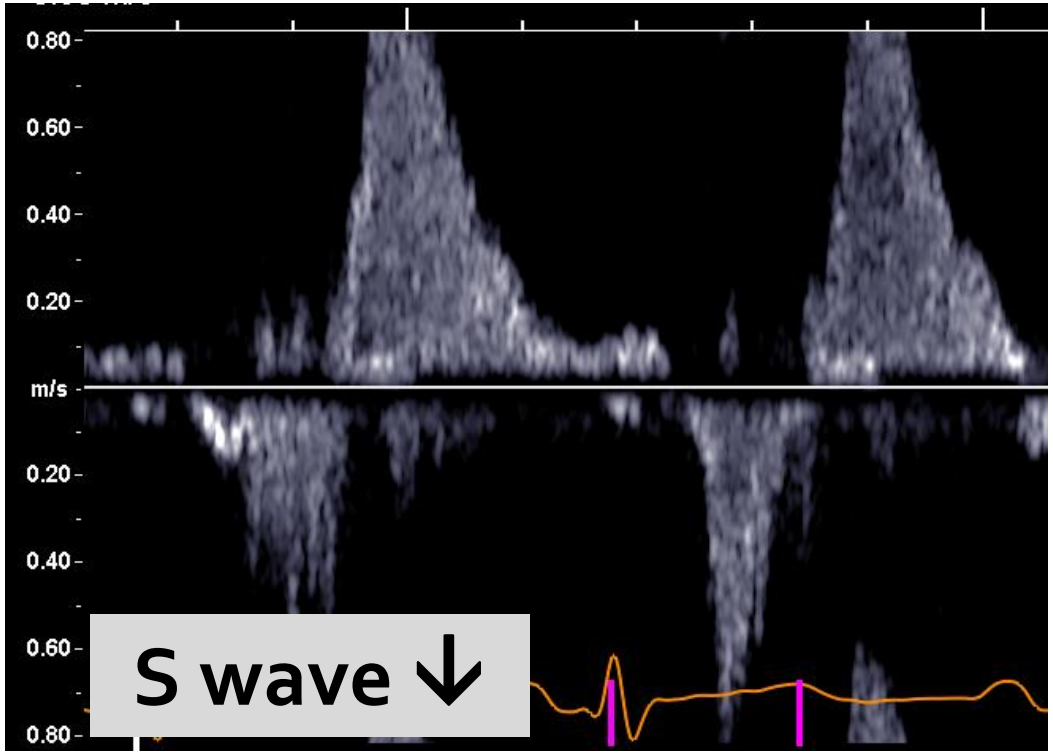


Post 3 Clips

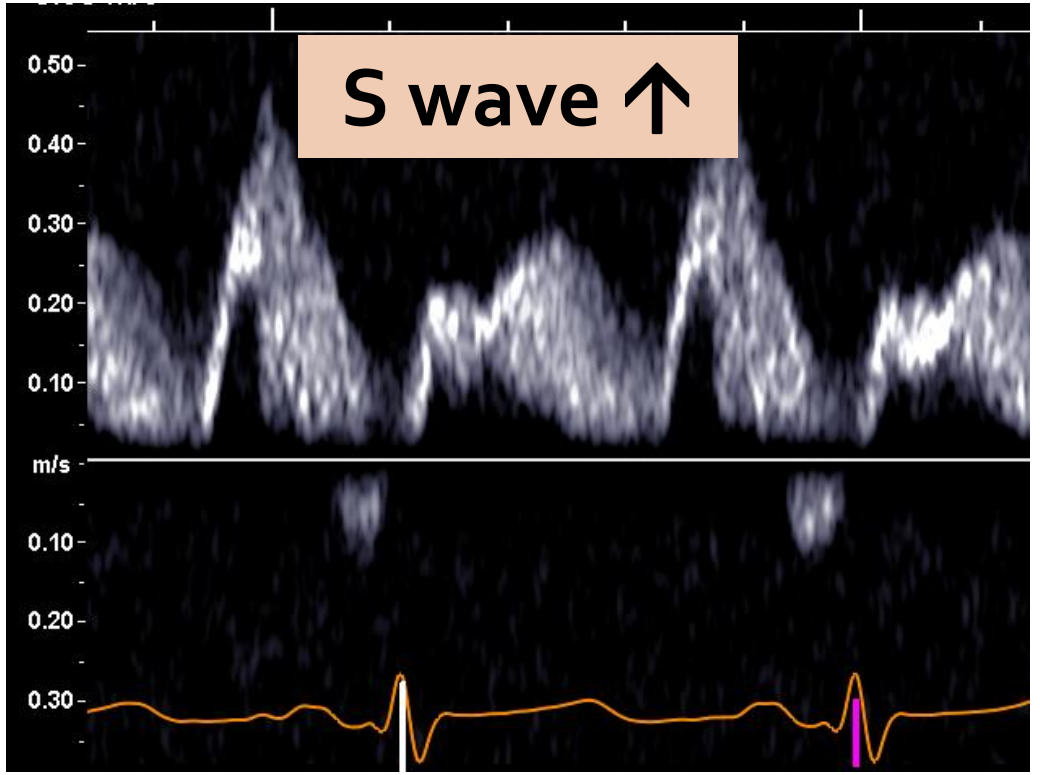


Procedural Success: Pulmonary Vein

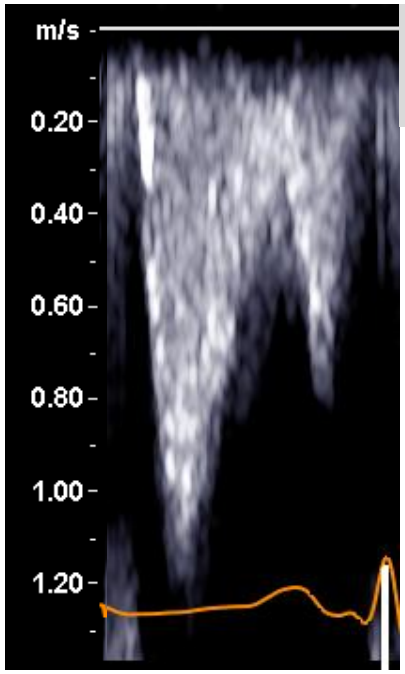
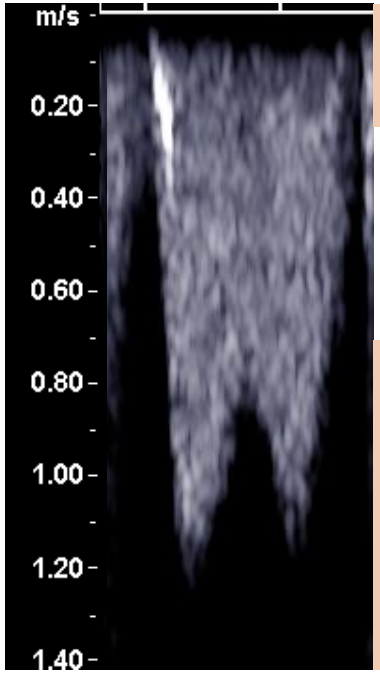
Baseline



Post 3 Clips

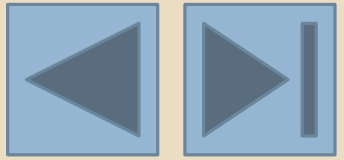


Procedural Success: Mitral Inflow

Baseline	Post 3 Clips
	
E >> A	E ~ A
	Mean Gradient 3 mm Hg at 80 bpm

Conclusion

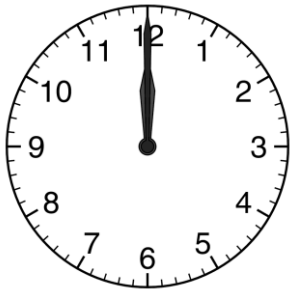
Functional mitral regurgitation treated successfully with implantation of 3 mitral clips



Question #1

67-year-old patient with severe functional mitral regurgitation and persistent symptoms despite medical therapy. Which of the following LVEF values qualifies the patient for a mitral clip procedure?

A. < 20 %
B. 20 – 50%
C. 35 – 50%
D. > 50%
E. > 60%



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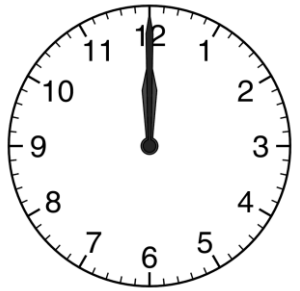
D. > 50%
E. > 60%

Question #2

Placement of a mitral clip is technically easiest in which of the following mitral valve locations?

A. A1/P1
B. A2/P2
C. A3/P3
D. Lateral commissure
E. Medial commissure



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B. A2/P2
C. A3/P3
D. Lateral commissure
E. Medial commissure

Thank You

New York University Langone Health